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Judith Curry, President  
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[curry.judith@cfanclimate.com](mailto:curry.judith@cfanclimate.com) | +1.404.803.2012  
<http://www.cfanclimate.net>

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**From:** Judith Curry <curry.judith@gmail.com>  
**Sent:** Sunday, April 27, 2025 2:54 PM  
**To:** Ross McKittrick  
**Cc:** Steven Koonin; Roy Spencer; John Christy; Travis Fisher  
**Subject:** Re: Global greening

Heres an idea for part 1

Chapter 5 Direct environmental impacts of CO2

5.1 Global Greening

5.2 Ocean Acidification

This way, both can be relatively short sections, and this way it fits logically into part I

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Craig Idso has a ton of good material on OA here

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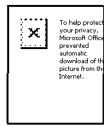
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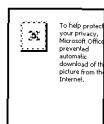
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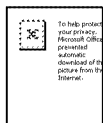
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[Influences -> Climate Response -> Impacts] should be the syllogism as it makes clear what we're trying to advise on.

So I'd advocate NOT making this change as it, in my mind, entangles the logical flow and dilutes the impact of the presentation.

Global greening is a (beneficial) response to human influences, not an influence itself. Partly a direct result of rising CO2, but also of higher temperatures. Logically belongs in Part III, clearly related to Ag improvements.

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**From:** Ross McKittrick <ross.mckittrick@gmail.com>  
**Sent:** Sunday, April 27, 2025 12:31 PM  
**To:** Judith Curry; John Christy; Roy W. Spencer; Steven Koonin; Travis Fisher  
**Subject:** Global greening

Currently GG is a single section later in the report. But it occurs to me that we treat it as a minor topic largely because the IPCC has buried it and has always focused heavily on the temperature issue. But we don't need to be bound by this especially because the growth effects and crop water productivity improvements are so strong. I think we should elevate it to something on par with the temperature issue and bring it up right at the beginning. That would mean an sequence of topics like this:

0 Front matter

Part I: Human influence on ecosystems and the climate

- 1 Carbon dioxide as distinct from criterion air contaminants
- 2 Global greening and CO2 fertilization
- 3 Components of anthropogenic radiative forcing and their history to date
- 4 The carbon cycle and future emission scenarios
- 5 Aerosols and the uncertainties associated with them

Part II: Climate response to greenhouse gas emissions

- 6 Measuring climate sensitivity to CO2 doubling
- 7 Models versus observations in recent past
- 8 Uncertainties in analysis of attribution
- 9 Evidence on trends and attributable changes in extreme weather
- 10 Sea level rise

Part III: Impacts on ecosystems and society

- 11 Climate change and US agriculture
- 12 Managing risks of extreme weather
- 13 Mortality risk from extreme heat and cold
- 14 Climate change and economic growth
- 15 Estimates of the Social Cost of Carbon
- 16 US vehicle-based CO2 emissions and the global climate

Same material but different order and an elevation of the importance of greening.

Any thoughts?

Ross



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**From:** Ross McKittrick [ross.mckittrick@gmail.com]  
**Sent:** 4/18/2025 6:28:52 PM  
**To:** Roy W. Spencer [roywspencer@hotmail.com]; John Christy [climateman60@gmail.com]; Steven Koonin [steven.koonin@gmail.com]; Travis Fisher [travis.scott.fisher@gmail.com]  
**Subject:** Section 1.6  
**Attachments:** 1.6 Climate Sensitivity.docx

Roy I took some text from an earlier piece you had written and combined it with my review of empirical ECS to produce a complete draft of Sect 1.6 which is now in your Dropbox folder.  
Also attached to this email.

## 1.6 Measuring Climate Sensitivity to CO<sub>2</sub> Forcing

### 1.6.1 Model-based methods of computing climate sensitivity to GHGs

Equilibrium Climate Sensitivity (ECS) is defined as the expected amount of warming averaged over the Earth's surface in response to a doubling of CO<sub>2</sub>, after all climate systems have had time to adjust. Some systems, like temperatures in the troposphere, adjust very rapidly. Others may take decades or even centuries, such as the deep ocean and the cryosphere. A related metric which is sometimes more helpful on shorter time scales is the Transient Climate Response (TCR) defined as the amount of warming after 70 years in which atmospheric CO<sub>2</sub> goes up by one percent annually.

Although ECS is of intrinsic scientific interest it is also of central importance to evaluating the public danger posed by GHG emissions. As will be discussed in Section 3.6, economic models take the ECS value from climate science and use it to project the costs of CO<sub>2</sub> emissions. The traditional ECS value (3.0 °C) has typically yielded modest global social costs of CO<sub>2</sub> emissions, whereas values closer to 2.0°C have been shown to be compatible with social costs of emissions being zero or even negative this century (Dayaratna et al. 2016, 2020). Obtaining a precise ECS estimate is therefore important for policy guidance.

In large-scale General Circulation Models (aka climate models) ECS is not imposed as a direct parameter, instead it emerges from the behaviour of the underlying components of the model. These, however, are under the control of the modeler, so ultimately a model's ECS can be said to be built into it. Direct warming from CO<sub>2</sub> doubling is only about 1°C (Hall and Manabe 1997); the rest, to the extent more happens, arises due to climate feedbacks which are inherently more difficult to predict and model.

In 1979 the Charney (1979) Report for the US National Academy of Sciences proposed that the most likely value for ECS was 3.0°C plus or minus 1.5°C. Hence the best estimate was a likely tripling of the CO<sub>2</sub> effect through feedbacks. With only minor variations this range was adopted and reaffirmed by the IPCC until the most recent AR6. The range has been obtained primarily by examining the behaviour of climate models, but since key components of models are under the control of modelers this is not dispositive of the actual climate's sensitivity.

There are approximately three dozen computer climate models operated by research groups around the world (Cannon 2024). They are referred to as GCMs which stands for either General Circulation Models or Global Climate Models. GCMs are valuable tools for understanding the climate system from a theoretical perspective. But the models have become so complex, often with 1 million or more lines of computer code (Brown-Steiner 2024), that it would be prohibitively expensive and time consuming for anyone to replicate the models' projections of climate change, let alone test the myriad model approximations embedded in the computer codes; a climate model typically takes hundreds of experts many years to develop (McSweeney and Hausfather 2018). As a result, these models are published in the scientific literature with little to no independent evaluation (Pirtle et al 2010). Climate modeling thus stands as an unusual class of scientific endeavor wherein researchers validating the scientific claims of others — a hallmark of science (National Academy of Science 2019)— becomes impractical, if not impossible.

While the models are often touted as being accurate representations of the “basic physics” governing the climate system, they still have problems with model “drift,” in which the models slowly change temperature over centuries for no apparent reason (Grandey et al. 2023). The tendency to drift is adjusted for by climate modelers by imposing the arbitrary assumption that

Earth's climate system does not produce long-term climate change, unless caused by humans (Sen Gupta et al 2013). By suppressing all slow-moving warming and cooling in this way this biases model-based research away from potential natural causes of climate change. In addition recent research suggests many models do not even conserve energy (Irving 2021) — a violation of the First Law of Thermodynamics. The First Law holds that energy can be neither created nor destroyed; to the extent that climate models fail to conserve energy, it can spontaneously appear (or disappear) for no apparent reason, causing a fictitious temperature change. This is a particularly important consideration since global warming theory is first and foremost based upon tiny changes in the global energy balance assuming the First Law holds.

For all these reasons it should come as no surprise that the various models' responses to a hypothetical doubling of atmospheric CO<sub>2</sub> above pre-industrial levels produces a very wide range of ECS values in current models, from 1.83°C to 5.64°C in the IPCC AR6. This wide range of responses — the largest in over 30 years of the global climate modeling enterprise — demonstrates large remaining uncertainties in climate modeling and thus in the projection of global climate impacts imputed to human activities. It also implies that ECS cannot be determined from climate models alone since the range is too wide to be informative. For that reason scientists have increasingly turned to empirical methods.

### 1.6.2 Empirical methods of computing climate sensitivity to GHGs

A significant amount of effort since the EF has gone into estimating ECS empirically. There are several challenges to this work.

- First, it requires good data but observations of some key climatic systems, especially the oceans, are available in only very limited amounts.
- Second, identifying the effect of CO<sub>2</sub> requires simultaneously identifying the effect of aerosols. Climate models exhibit warming in response to GHGs but cooling in response to aerosols (Schwartz et al. 2007). Observed 20<sup>th</sup> century warming can be shown to be consistent either with low ECS and low aerosol cooling or high ECS and high aerosol cooling. Since fossil fuel use adds both GHGs and aerosols to the atmosphere, both effects need to be estimated to isolate the warming effect of CO<sub>2</sub>. Over time the IPCC's estimate of the cooling effect of aerosols has declined (Lewis 2022).
- Third, the simple empirical model typically used for the estimation, called an Energy Balance Model, requires estimating a feedback parameter which appears in the denominator of the equation for ECS. A small amount of uncertainty about the number in the denominator of a fraction can lead to very large uncertainties in the magnitude of the fraction itself. Roe and Baker (2007) pointed out that uncertainties in climate feedbacks are "highly amplified" in the resulting ECS.

Since 2012 many studies have appeared in the literature tackling these various uncertainties. A recurring theme is that ECS estimates based on historical data turn out to be smaller than ECS estimates encoded in climate models (Sherwood and Forest 2024). An early estimate (Stern and Kaufmann 2000) was 1.6°C, though this predated development of the Energy Balance Model method. Figure 1.6.1 shows the point or best estimates from 17 subsequent studies all appearing in the peer-reviewed literature after the TSD. The Charney range is shown for contrast. The average ECS estimate in the post-2012 sample is 1.8°C. The highest estimate, from Sherwood et al. 2020, is shown in red: it is the one that was used by the IPCC for the AR6 (Forster et al. 2021). The one

adjacent to it, Lewis (2022), shows the result of, among other things, using the same statistical method (Bayesian inference) but applying more updated aerosol forcing data in the AR6 as well as some other recent updates to the source data. These updates dropped the ECS best estimate to 2.2°C closer to the usual empirical range. The IPCC, following Sherwood et al. (2020) had estimated only a 5 percent probability that ECS was below 2.3°C, whereas Lewis (2022) estimated it was over 50 percent.

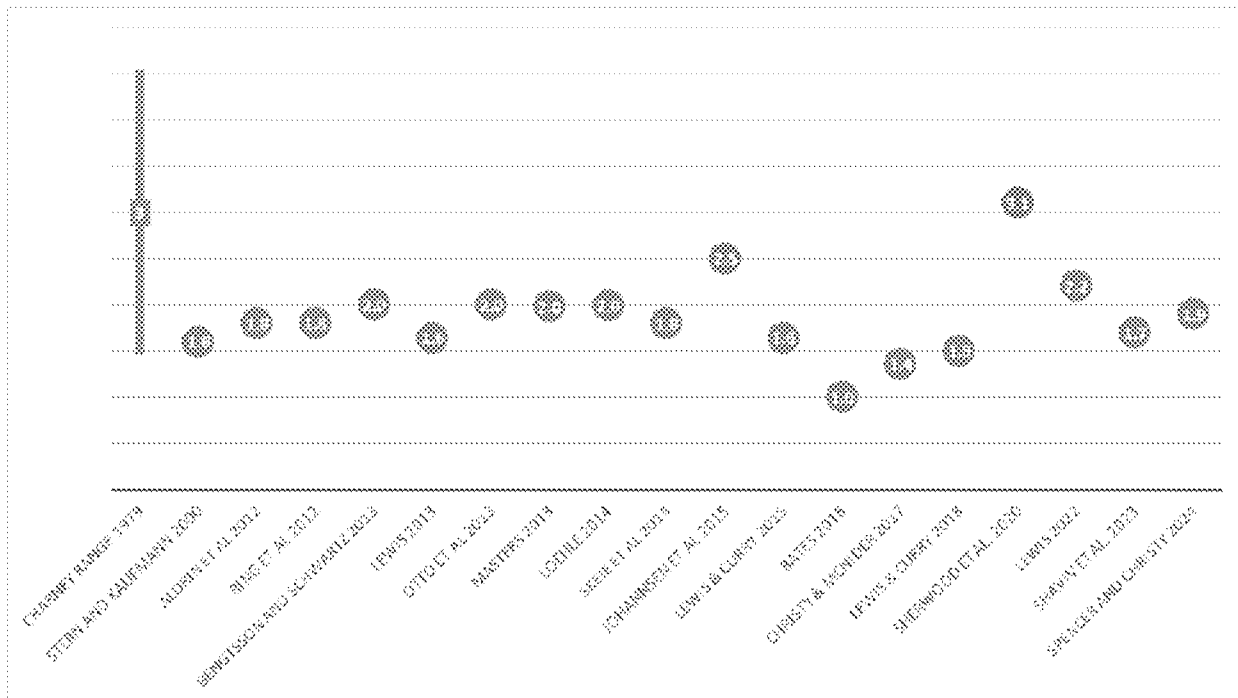


Figure 1.6.1: Empirical best estimates of ECS

A recent hypothesis, which the IPCC AR6 emphasized, is that empirical ECS estimates might understate the future warming response to GHGs due to a so-called “pattern effect” (Forster et al 2021). The tropical Pacific is believed to be highly influential on the overall efficiency with which the Earth’s climate radiates heat to space, but heat in some parts is more efficiently removed than from others. If in a warming climate there is a weakening of the west-to-east temperature gradient in the tropical Pacific the result would be a concentration of warming in a region where heat is less efficiently removed, raising the ECS of the Earth’s climate system. Most climate models simulate that rising GHGs will weaken the east-west temperature gradient, which led the IPCC in the AR6 to conclude that empirical ECS estimates understated what would be the *future* observed ECS value.

However Seager et al. (2019) pointed out that, contrary to models, the east-west temperature gradient has been strengthening rather than weakening over time. They further argued that the mechanism predicting otherwise in climate models was based on a faulty characterization of oceanic dynamics and there is no reason to expect the gradient to weaken. A similar argument was recently made by Lee et al. (2024), who concluded that “the trajectory of the observed trend reflects the response to increasing GHG loading in the atmosphere”, in other words GHG warming should lead to a future strengthening rather than a weakening of the temperature gradient.

Increased efficiency of atmospheric cooling implies, if anything, that the future ECS in a warming climate may be *lower* than at present.

As discussed in Section 1.4.2 a real-world ECS below the model average is supported by studies which show climate models on average estimate too much warming at the surface and in the troposphere compared to observations over the past 50 years. Also it aligns with evidence from consistent fingerprinting (Section 1.5.1) that model responses to GHGs need to be scaled down quite a bit to align with observed trends.

In summary:

- ECS cannot be determined from climate modeling alone since models are too complex and uncertain to narrow the range
- Climate models on average embed process assumptions that yield a projected warming of about 3.0°C from CO<sub>2</sub>. Empirical estimates since the TSD however imply the climate is much less sensitive to CO<sub>2</sub> than this.
- A large number of empirical estimates have been published centered at or below 2°C. This aligns with other independent forms of empirical evidence pointing towards low ECS.

---

**From:** John Christy <climateman60@gmail.com>  
**Sent:** Friday, April 18, 2025 12:24 PM  
**To:** Ross McKittrick  
**Cc:** Roy Spencer; Travis Fisher; Steven Koonin  
**Subject:** Re: Section 1.4.2 Can climate models reproduce the recent past?

Ross

Attached are three figures relative to the vertical profile in the tropics.

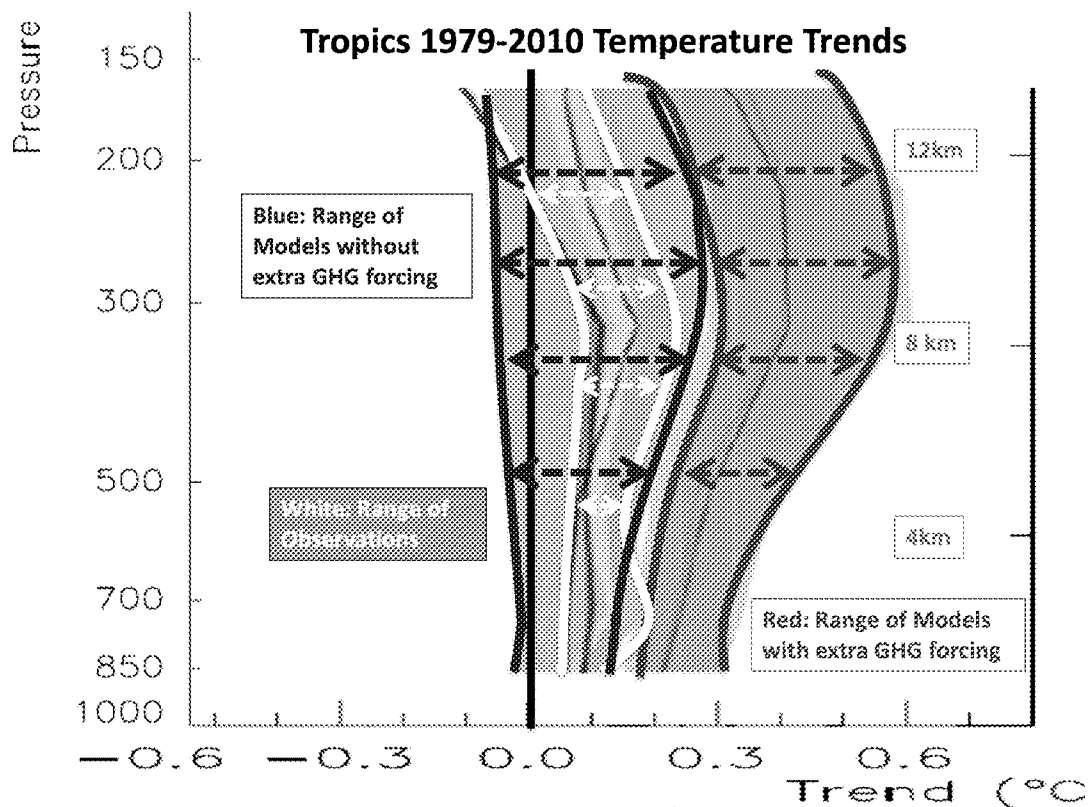
1.4.2a - Corrected version of the IPCC annotated chart that was in the EF draft (Fig. 1.4.8 I think - it was actually through 2010, not 2011)

1.4.2b - Fig 3 from Christy and McNider 2017, trends through 2015

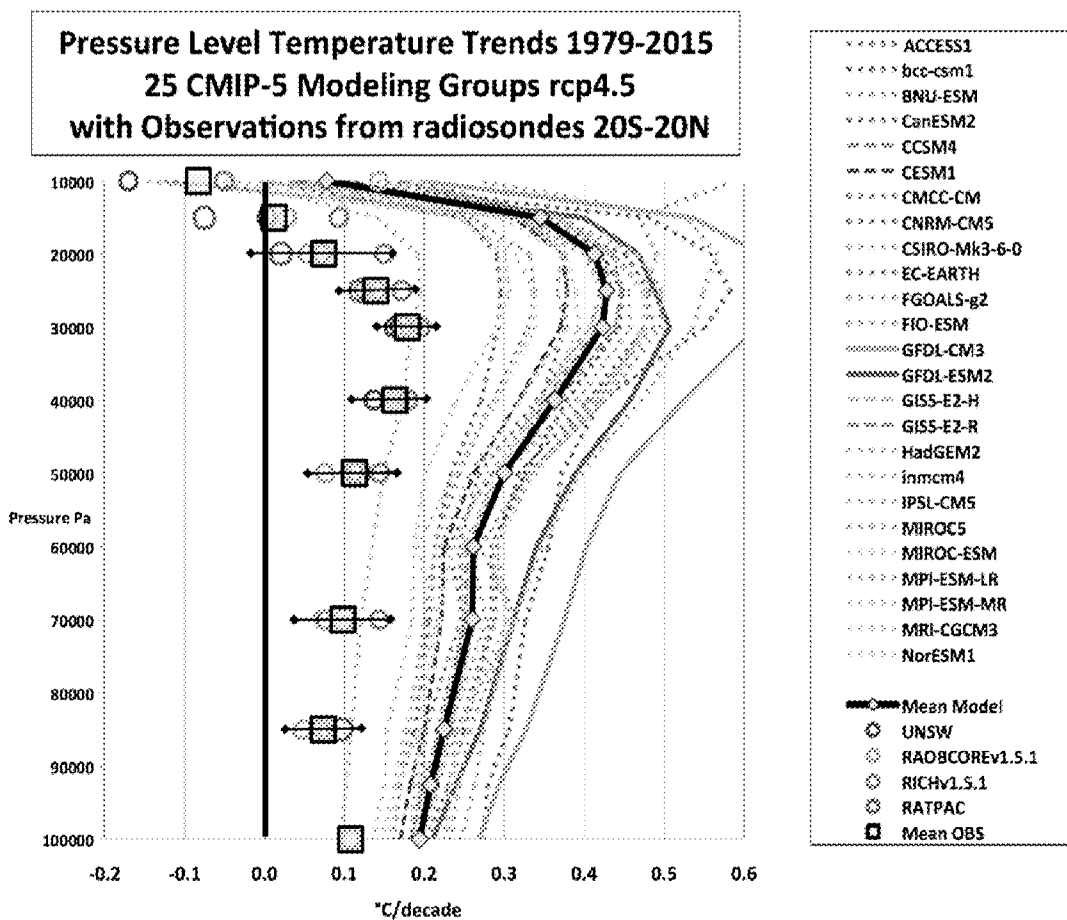
1.4.2c - Updated CM2017 figure through 2024 and using CMIP6 models. Note at top I have included the layer average (TTT) so satellites can be included and shows these models are all warmer in the bulk average than the observations even though a couple of the coldest models might hit one of the observations at a specific level. JQ5 is the new version of the Japanese Reanalyses. The fact all models are warmer than the observations even when including the big El Ninos of 2016 and 2024 is revealing. Also the ERA5 and JQ5 layer trends were identical, so you can't see two boxes in the layer average. These figures as make the point that improvement has not been forthcoming after all these years. Through 2024, TTT obs mean +0.17 C/dec, model mean +0.31 C/dec.

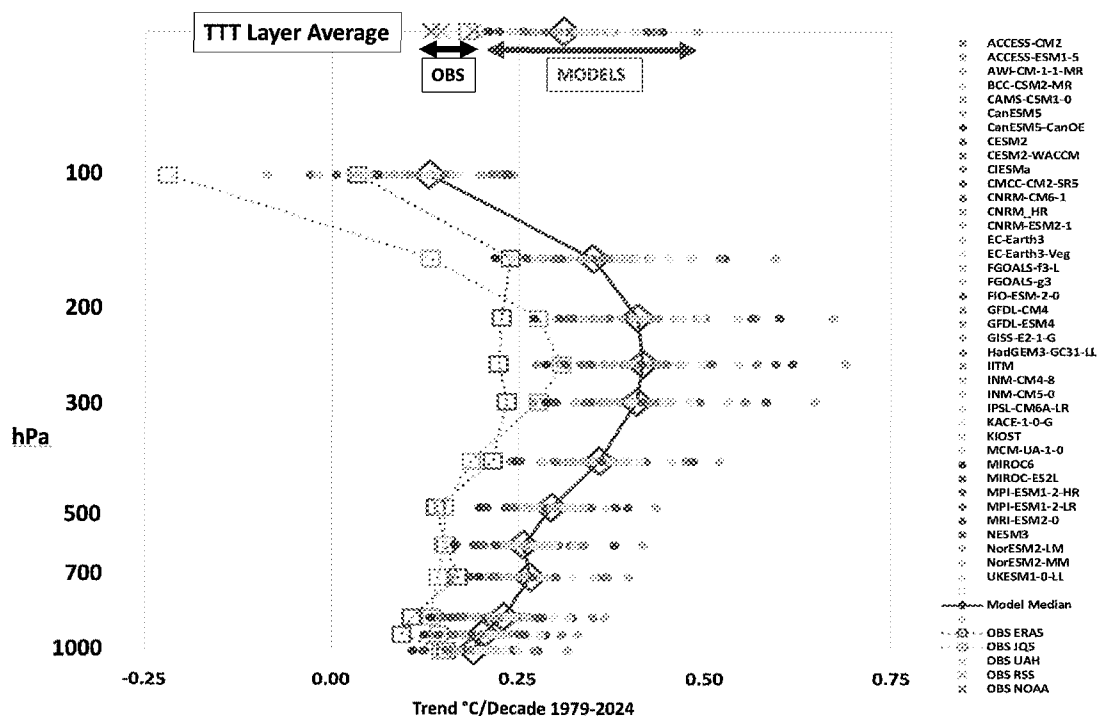
I find it also interesting that the Japanese and Europeans deconvolve the deep-layer satellite soundings into pressure levels a little differently above 400 hPa so that JQ5 is warmer than ERA around 300-200 hPa but is cooler above 100 hPa. So, in the layer-average they are the same (which is the constraint of the deep layer inputs).

John C.



IPCC AR5 Fig 10.SM.1 20° S-20° N





On Thu, Apr 17, 2025 at 8:51 AM Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:

OK this is weird it keeps reattaching Roy's version not my revised version. I put my version in the Dropbox folder.

On Thu, Apr 17, 2025 at 9:49 AM Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:

Sorry wrong attachment

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I had a pile of stuff at hand for another project, so I added it in, if that's ok. I liked your Heritage report and thought those graphs would be good.

On Thu, Apr 17, 2025 at 7:17 AM Roy Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)> wrote:

Attached. This is the minimum I think needs to be in this section. Of course, more could be added, but I think we need to stick to our strongest arguments, given the limited time available.

-Roy

**From:** Roy Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>

**Sent:** Wednesday, April 16, 2025 7:16 AM

**To:** Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>; Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>

**Cc:** Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>; John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>

**Subject:** Some Spencer inputs

I took it upon myself to write a preamble in **Section 1.3 Drivers of climate change** (attached), which seemed necessary to introduce some basic concepts.

Also attached are my initial submissions for **1.3.2** and **1.3.3**.



**NO references** added yet.

One of the things I believe we need to watch out for is *neglecting to come to conclusions along the way...* There is a tendency to get mired in the technical details without getting around to saying what each section might mean in eventual policy decisions related to the Endangerment Finding. In my experience, it is not possible to dumb-down this stuff too much. I suggest some sort of "Summary Boxes" with 1-2 simplified statements highlighting a main conclusion of each section that would have policy relevance.

-Roy

---

**From:** Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>

**Sent:** Monday, April 14, 2025 1:37 PM

**To:** Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>

**Cc:** Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>; John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>;  
[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com) <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>

**Subject:** Re: Kickoff

Hi Travis

We developed the outline a bit further and assigned sections out yesterday. We'll keep you cc'd going forward.

Here is a Dropbox link that contains the current outline (also attached) which indicates who is working on each section

[https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyrr8x/ANTU1qAQJ-zXCFzP\\_gsJcOs?rlkey=l1z3qj9v46elt5f4ywwwxq7p8c&dl=0](https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyrr8x/ANTU1qAQJ-zXCFzP_gsJcOs?rlkey=l1z3qj9v46elt5f4ywwwxq7p8c&dl=0)

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I put folders in there for each of us. If the use of that Dropbox (which is on my own account) is acceptable for this project then we can share our work using it. Otherwise once we have an official Dropbox created we can transfer the material over to it.

Do you think it would be helpful to have a section specifically addressing the question of whether CO2 is a pollutant like CO, NOx, SOx, PM, etc.? If you want to add topics or suggest changes please do, the earlier the better as we begin filling out the contents.

Cheers,

Ross

On Mon, Apr 14, 2025 at 2:12 PM Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:

This is an excellent start! Can we move forward by iterating with this document for now? Please feel free to add whatever material you like, and I can collate if there are any simultaneous changes. I will leave the substance to you all because I view my role as a facilitator rather than a contributor, but please let me know how I can be most helpful.

Steve is correct that this document should be clear and understandable for non-experts. My understanding is that it should also be sufficiently technical and comprehensive to inform policymakers on all relevant aspects of the science.

One area I can help with might be targeting your work for the very brief window we have open at the moment. I am including a few lines verbatim below from key documents to highlight the areas of inquiry

that are most relevant to the policymaking process. Of course, you all should make your own judgments about what to include versus what to leave out.

Here is a key section of the Clean Air Act, 202(a)(1): "The Administrator shall by regulation prescribe (and from time to time revise) in accordance with the provisions of this section, standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare. Such standards shall be applicable to such vehicles and engines for their useful life (as determined under subsection (d), relating to useful life of vehicles for purposes of certification), whether such vehicles and engines are designed as complete systems or incorporate devices to prevent or control such pollution."

Section 202 can be found [here](#).

Here is another key section of the Clean Air Act, section 302(g): "The term 'air pollutant' means any air pollution agent or combination of such agents, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and byproduct material) substance or matter which is emitted into or otherwise enters the ambient air. Such term includes any precursors to the formation of any air pollutant, to the extent the Administrator has identified such precursor or precursors for the particular purpose for which the term 'air pollutant' is used."

A threshold question raised in Justice Scalia's dissent in *Mass v. EPA* (which can be found [here](#)) is whether CO2 falls under the definition of an "air pollutant" under the Clean Air Act. The majority in *Mass v. EPA* found that *any* compound emitted into the ambient air fits the definition of "air pollutant," leading to a colorful footnote in the Scalia dissent ("It follows that everything airborne, from Frisbees to flatulence, qualifies as an 'air pollutant.' This reading of the statute defies common sense."). A scientific interpretation of this definition could be very helpful.

The next section in the statute is 302(h), which defines effects on welfare: "All language referring to effects on welfare includes, but is not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants." Positive impacts, including fertilization effects and beneficial warming, seem to be within scope here.

Section 302 can be found [here](#).

As you all develop the draft, I encourage you to include as many citations to published materials as possible (links would work fine as placeholders). I have found this works better under a tight timeline than going back and looking for sources later. Please also feel free to task me with any research help you might need.

Best,  
Travis

On Fri, Apr 11, 2025 at 8:10 PM Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)> wrote:

I assume we're writing for non-experts. If so, some educating beyond the root questions is in order (it always helps if people feel smarter after reading).

So I've taken Ross' material, added some broader context, and cast it into the forcing/response/impact syllogism that most non-experts seem to get. The result is attached.

I think we can deal with the differences relative to 2009 in an appendix.

SEK

---

**From:** John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>  
**Sent:** Friday, April 11, 2025 6:34 PM  
**To:** Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>  
**Cc:** Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>; [steven.koonin@gmail.com](mailto:steven.koonin@gmail.com); [roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)  
**Subject:** Re: Kickoff

Excellent list Ross. Wildfires are a significant topic to be addressed.

John C.

Sent from my iPhone

On Apr 11, 2025, at 4:05 PM, Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:

The attached represents my summary of the most questions needing to be answered, which I think this group is capable of answering in the next couple of weeks. Probably lots of material already in hand.

On Fri, Apr 11, 2025 at 4:24 PM Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:

| Gentlemen,

I can't thank you enough for taking this on under such a tight timeline. Let's use this thread to exchange information, links, etc., and as we move forward, I'll see about a document-sharing platform and a shared document to work on simultaneously.

Best,

Travis

<DE.memo.outline.Apr.11.[RM].docx>

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**Sent:** Thursday, April 17, 2025 9:52 AM  
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## Section 1.4.2

Climate models are the primary tool used to project future climate changes in response to increasing atmospheric levels of anthropogenic greenhouse gases. They provide the theoretical evidence underpinning energy policy changes, such as efforts to reduce carbon dioxide emissions. In order to determine the value of climate models for this purpose, it is reasonable to ask how well they have reproduced climate variations over the recent past, say the last half-century.

Of great concern is the fact that, after several decades of the climate modeling enterprise involving approximately two dozen models operated by research centers around the world, the range of future warming they produce in response to a hypothetical doubling of atmospheric CO<sub>2</sub> (2XCO<sub>2</sub>) extends over a factor of three. This range of disagreement between models has not changed for decades.

Problems with climate models are not just in their disagreement over the future, but also in their ability to replicate the recent past. Here we review some of the most important metrics of climate model accuracy: ability to reproduce historical surface, tropospheric and stratospheric temperature trends, ability to reproduce the vertical warming profile and ability to reproduce other climate features such as snowfall and humidity. In all cases a persistent finding is that models on average err on the side of too much warming in response to observed historical forcings.

### Surface warming

A straightforward test of climate model validity is its ability to reproduce historical warming in response to known past changes in climate drivers such as greenhouse gases. The following diagram is from Scaffeta (2023), a peer-reviewed 2023 study which groups the latest-generation (CMIP6) climate models into low ECS (1.5 to 3.0 degrees C), medium ECS (3.0 to 4.5 degrees C) and high ECS (4.5 to 6.0 degrees C), and compares their post-1980 global average temperature simulation ranges to those of three surface temperature records and one satellite-based lower troposphere temperature data product. Figure 1.4.1 summarizes the comparisons.

Columns correspond to model groups showing low-ECS to high-ECS. Rows correspond to widely-used observed temperature records, the first three showing surface averages and the fourth showing the lower troposphere average. In each panel the yellow area denotes the mean and range ( $\pm$  one standard deviation) of climate model simulations for that group. The thick black line shows the observed annual average temperature in the indicated source.

Examination of the leftmost column shows that the low-ECS models track the post-1980 historical warming record reasonably well, but the middle and right columns show that the medium- and high-ECS models conspicuously over-predict the warming.

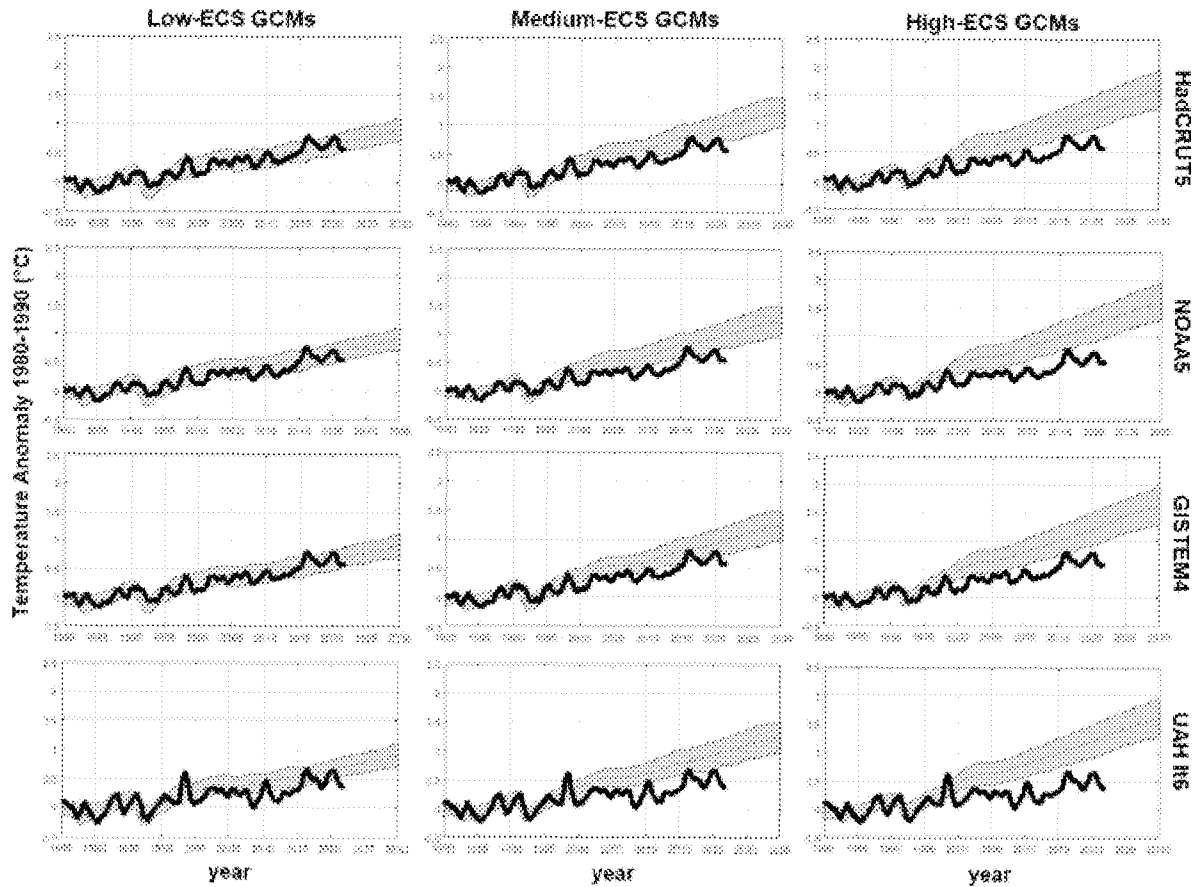


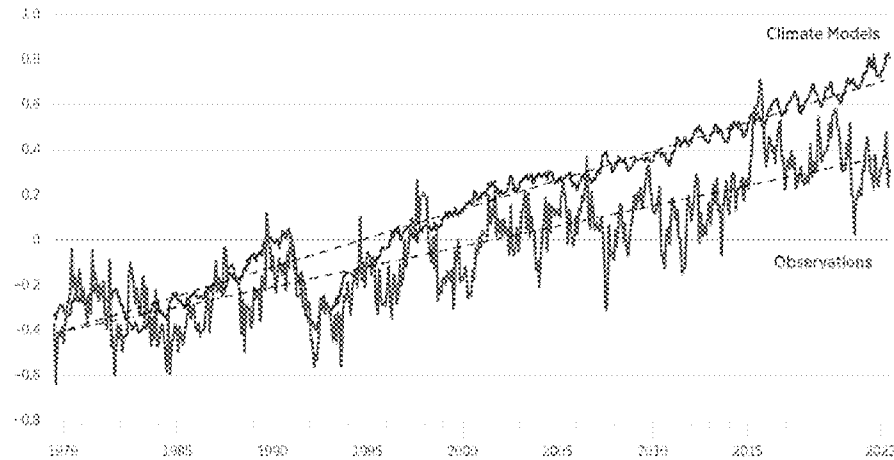
Figure 1.4.1: model-observational comparisons for Earth's surface warming. Source: Scafetta N. Climate Dynamics 2023 Fig.2. Rows: temperature data products as indicated. Columns: Low- to High-ECS models. Observations: black line. Model simulations: yellow band.

Spencer (2024) has also provided a useful summary of the Model-Observation mismatch by focusing on average surface temperature data products versus the average climate model warming, summarized in Figure 1.4.2.

CHART 1

### Global Average Surface-Air Temperature Variations, 1979~2022

DEPARTURE FROM 1951-2020 AVERAGE, IN DEGREES CELSIUS



**NOTE:** Figures have been adjusted to align trends starting in 1979.

**SOURCES:** Authors' calculations based on data from five different observation-based datasets and 35 climate models taking part in the sixth IPCC Climate Model Intercomparison Project, and KNMI Climate Explorer, "Starting Point," <https://climate.knmi.nl/Start.asp> (accessed January 10, 2024).

Figure 1.4.2: Models versus observations at the surface. Source: Spencer (2024)

### Tropospheric warming

It has long been known that climate models on average overstate warming in the troposphere over the tropics. This was flagged as a serious inconsistency in 2006 in the first US Climate Change Science Program report (Karl et al. 2006) and has been mentioned in every IPCC report since. But instead of the problem being corrected, it's gotten worse over time, and the bias is now global. McKittrick and Christy (2020) compare tropospheric warming rates in the new generation CMIP6 climate models to observations from satellites, weather balloons and reanalysis systems. Every single model overpredicts warming. Every model over-predicts warming in both Lower- and Mid-Troposphere layers, both globally and in the tropics.

In most individual cases the bias is statistically significant and on average it is highly significant. They also show that the bias is larger in high-ECS models, but even the models with lower average ECS predict too much warming. If a group of models were to appear that had a realistic representation of global tropospheric warming, it would likely have to have a lower ECS than even the low-ECS members of the CMIP6 ensemble

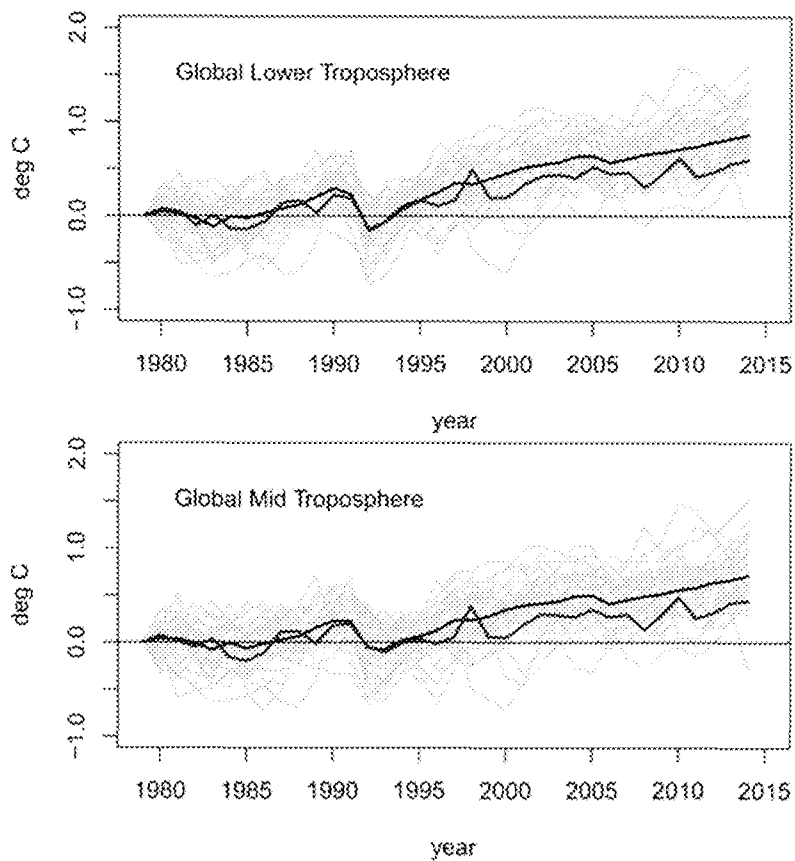


Figure 1.4.3: Models versus observations in the global troposphere. Source: McKittrick and Christy (2020).

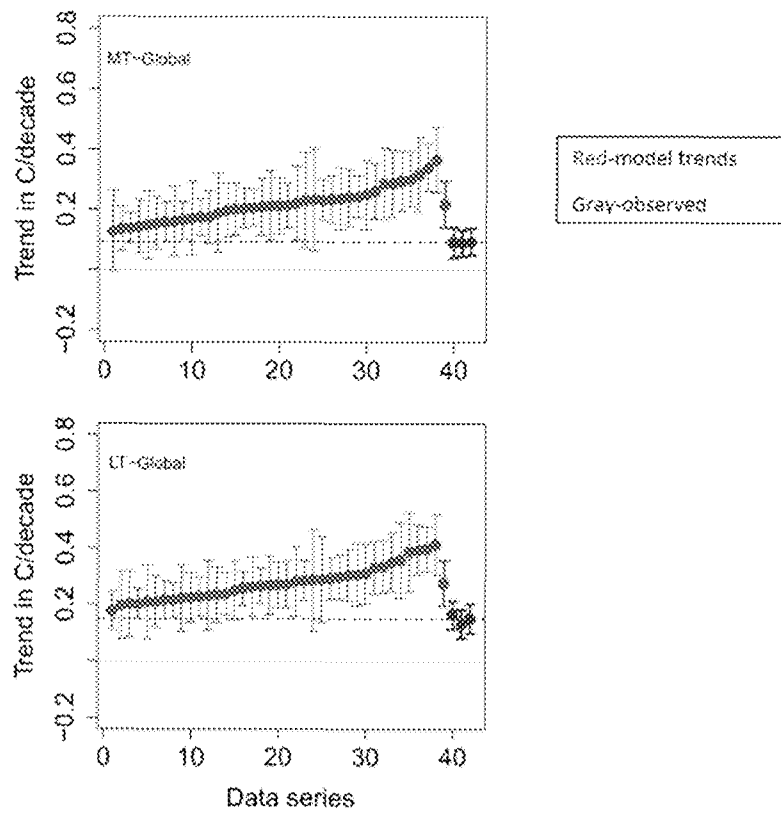


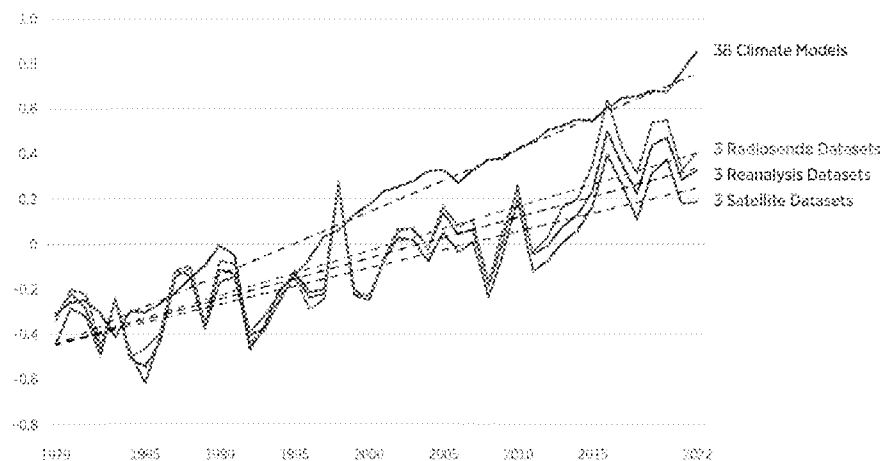
Figure 1.4.4: Modeled versus observed warming trends in the global troposphere. Adapted from McKittrick and Christy (2020).

Spencer (2024) shows the mismatch is also present in the lower troposphere:

CHART 1

## Global Lower Atmospheric Temperature Variations, 1979~2022

DEPARTURE FROM 1991-2020 AVERAGE, IN DEGREES CELSIUS



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- Author's calculations based on data from Ross McKittrick and John Christy, "Persistent Warming Bias in CMIP6 Tropospheric Layers," *Earth and Space Science*, Vol. 7, No. 11 (Nov. 14, 2020), <https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2020EF000128> (accessed January 10, 2023).
- Author's calculations based on data from American Meteorological Society, *State of the Climate in 2022*, <https://www.wamweather.gov/index.cfm/press/publications/bulletin-of-the-american-meteorological-society-bams/state-of-the-climate/> (accessed January 9, 2023).

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**Figure 1.4.5:** Comparison of average trends in lower troposphere, 1979-2022. Source: Spencer (2024).

As mentioned the IPCC has long acknowledged the model-observational mismatch. The AR6 pp. 443-444 confirms model-observational mismatch in the troposphere the tropics (it does not address global comparison):

Several studies since AR5 have continued to demonstrate an inconsistency between simulated and observed temperature trends in the tropical troposphere, with models simulating more warming than observations (Mitchell et al., 2013, 2020; Santer et al., 2017a, b; McKittrick and Christy, 2018; Po-Chedley et al., 2021)... Over the 1979–2014 period, models are more consistent with observations in the lower troposphere, and least consistent in the upper troposphere around 200 hPa, where biases exceed 0.1°C per decade. Several studies using CMIP6 models suggest that differences in climate sensitivity may be an important factor contributing to the discrepancy between the simulated and observed tropospheric temperature trends (McKittrick and Christy, 2020; Po-Chedley et al., 2021), though it is difficult to deconvolve the influence of climate sensitivity, changes in aerosol forcing and internal variability in contributing to tropospheric warming biases (Po-Chedley et al., 2021). Another study found that the absence of a hypothesized negative tropical cloud feedback could explain half of the upper troposphere warming bias in one model (Mauritsen and Stevens, 2015).

... In summary, studies continue to find that CMIP5 and CMIP6 model simulations warm more than observations in the tropical mid- and upper-troposphere over the 1979–2014 period (Mitchell et al., 2013, 2020; Santer et al., 2017a, b; Suárez-Gutiérrez et al., 2017; McKittrick and Christy, 2018), and that overestimated surface warming is partially

responsible (Mitchell et al., 2013; Po-Chedley et al., 2021). .... Hence, we assess with *medium confidence* that CMIP5 and CMIP6 models continue to overestimate observed warming in the upper tropical troposphere over the 1979–2014 period by at least 0.1°C per decade,

## Vertical profile mismatch

An important element of the model-observational discrepancy is the excess amplification with altitude found in climate models. A comparison was shown in the IPCC AR5 Chapter 10, although only in the online supplement. The diagram compares temperature trends by altitude between models and observations, divided up into latitude bands:

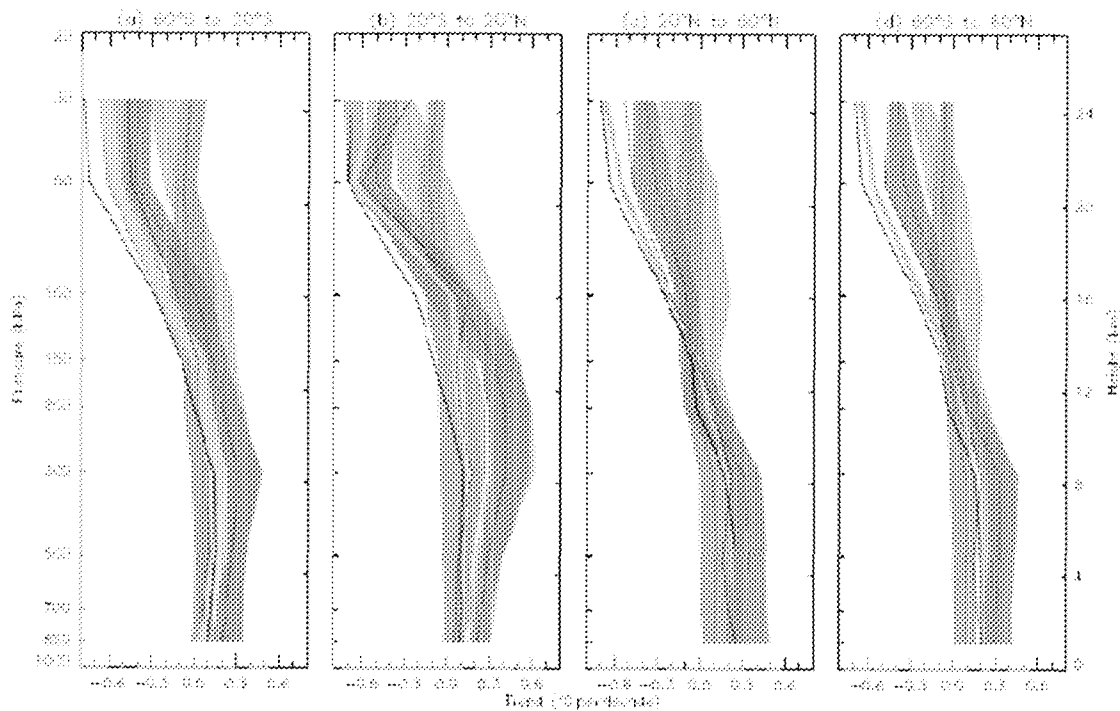


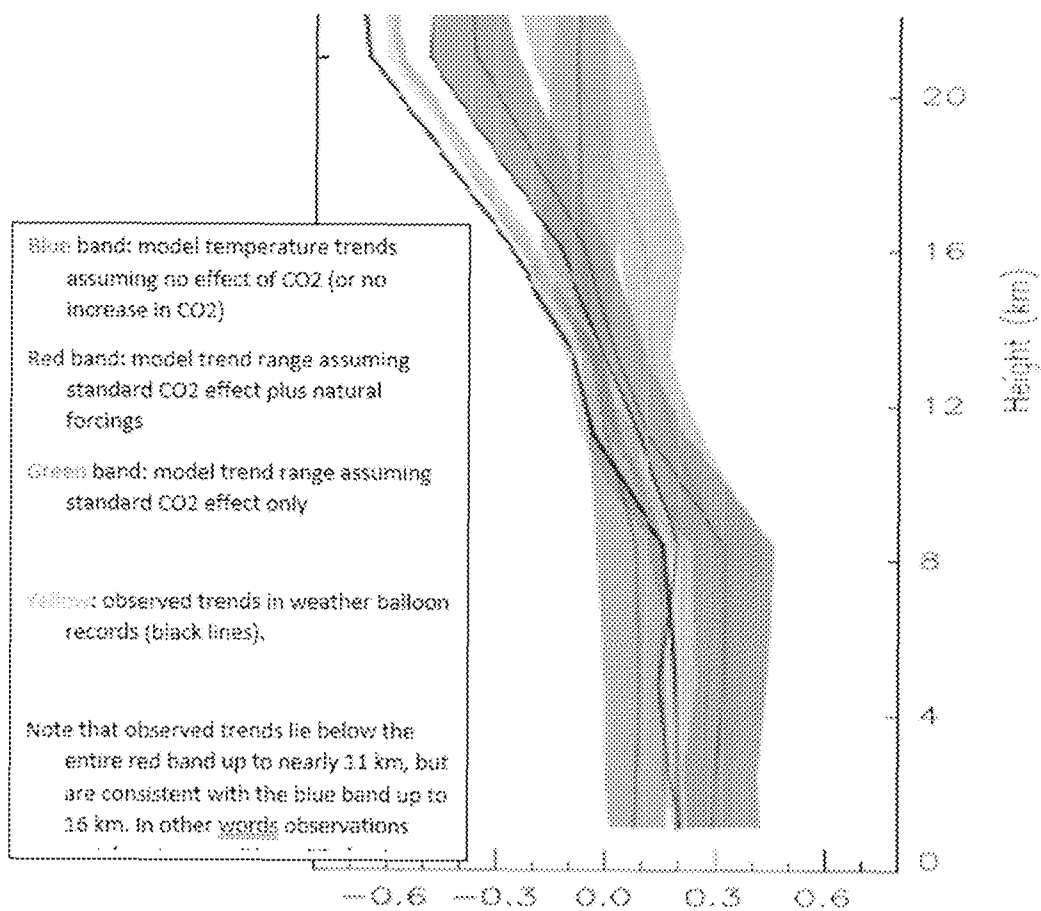
Figure 10.SM.1 | Observed and simulated mean temperature trends from 1979 to 2010 for CMIP5 simulations containing both anthropogenic and natural forcings (a-d), natural forcings only (blue) and greenhouse gas forcing only (green) where the 5th to 95th percentile ranges of the ensembles are shown. Three radiance observations are shown (black, black line Hadley Centre Atmospheric Temperature data set 2 (HadAT2), thin black line: Radiance Observation Correction using M-analysis (RAOCORR) 1.5, dark gray band, Radiance Observation Composite reanalysis (RoCOR-com) 1.5 ensemble and light gray RoCOR-com 1.5 ensemble. (Adapted from Lott et al. (2013) but for the more recent period from 1979 to 2010.)

10528-6

**Figure 1.4.6:** Vertical warming pattern by latitude band. Source: IPCC AR5 Figure 10.SM.1

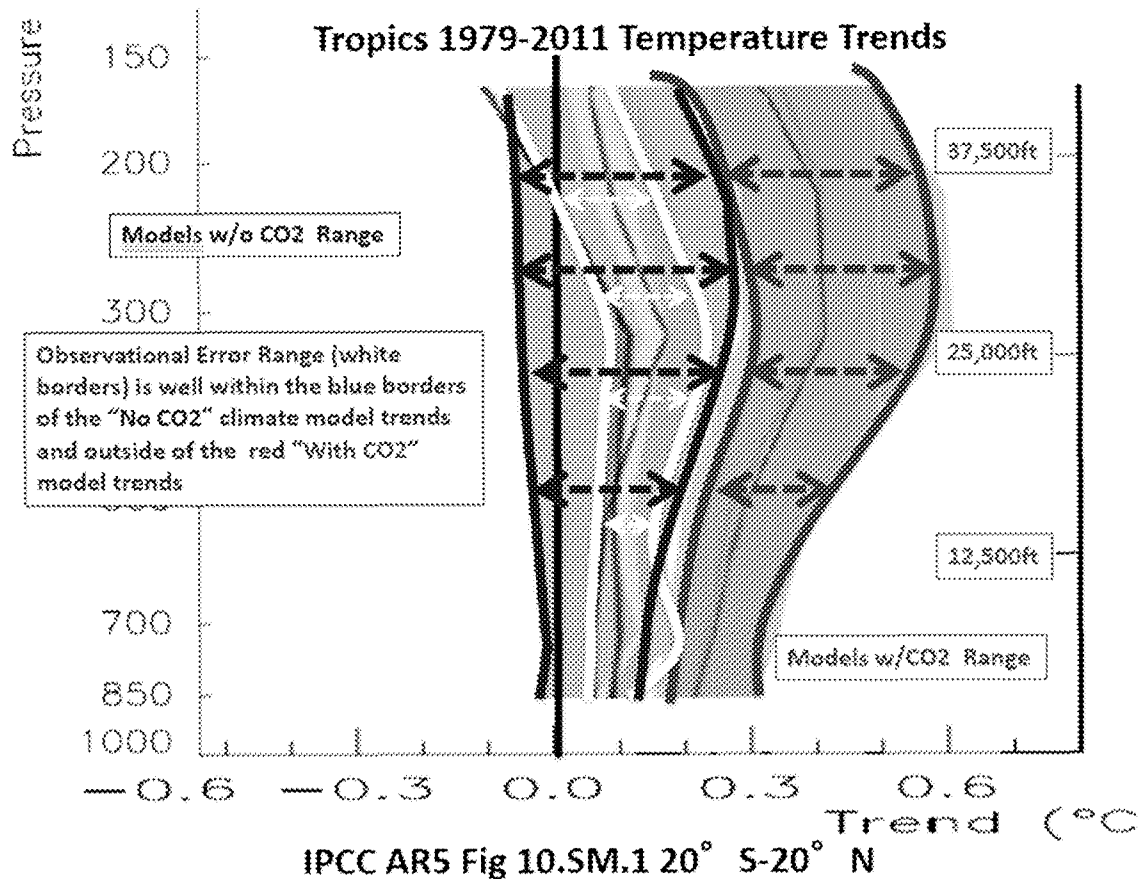
The Figure is not referenced in the main report nor in any summary. What it shows, although it is not apparent at first glance, is that the 1979-2010 warming in the lower troposphere is so minimal it is consistent with models having no GHG forcing in them, and is inconsistent with the model runs that do have GHG forcing. Here is the main global band (60S to 60N) expanded with the observed trends highlighted in yellow:





**Figure 1.4.7:** Adapted from IPCC AR5 Figure 10.SM.1

John Christy has drawn further detail out of the tropics band as follows:



**Figure 1.4.8:** Adapted from IPCC AR5 Figure 10.SM.1

In the tropics, where the models say the warming should be strongest, the observations (shown here in white) lie within the "No CO<sub>2</sub>" band and entirely outside the "with CO<sub>2</sub>" red envelope. This means that in the entire atmospheric column from the surface to the stratosphere, *observed warming trends are so small they are consistent with the output of models that have no CO<sub>2</sub> warming effect in them, and they are inconsistent with the entire envelope of warming trends generated by models forced with increased CO<sub>2</sub>.*

Some defenders of the models have argued that even if there is very little observed warming, the tropical warming "hotspot" still exists in the sense that the warming aloft is greater than at the surface. But there is good evidence that models also exaggerate the amplification rate. Klotzbach et al. (2009)m which was not discussed in the AR6, showed that models project greater amplification with altitude than is observed. That paper gave rise to an online debate over whether the amplification rates were being correctly calculated, and whether the discrepancy between models and observations was statistically significant. The topic involves very advanced statistical theory and was dealt with by two experts in time series analysis (Vogelsang and Nawaz 2016) who found that Klotzbach's conclusions were valid, and that observed amplification is significantly smaller than the model-projected rates. The IPCC AR6 made no mention of this work either.

## Stratospheric cooling

An important element of the expected general “fingerprint” of anthropogenic climate change is simultaneous warming of the troposphere and cooling of the stratosphere. The IPCC AR6 acknowledged that cooling had been observed but only up to 2000. Thereafter the stratosphere has exhibited some warming, contrary to model projections.

The AR6 WG1 Ch 2 pp. 327-9 states:

“Temperatures averaged through the full lower stratosphere (roughly 10–25 km) have decreased over 1980–2019 in all data products, with the bulk of the decrease prior to 2000. The decrease holds even if the influence of the El Chichon (1982) and Pinatubo (1991) volcanic eruptions on the trend, found by Steiner et al. (2020a) to have increased the 1979–2018 cooling trend by 0.06°C per decade, is removed. **Most datasets show no significant or only marginally significant trends over 2000–2019, and the results of Philipona et al. (2018) show weak increases over 2000–2015** in the very lowermost stratosphere sampled by radiosondes....

It is virtually certain that the lower stratosphere has cooled since the mid-20th century. However, most datasets show that **lower stratospheric temperatures have stabilized since the mid-1990s with no significant change over the last 20 years**. It is likely that middle and upper stratospheric temperatures have decreased since 1980, but there is low confidence in the magnitude.

The cited source, Philipona et al. (2018), in an article entitled “Radiosondes Show That After Decades of Cooling, the Lower Stratosphere Is Now Warming”, stated:

“In response to continued greenhouse gas increases and stratospheric ozone depletion, climate models project continued tropospheric warming and stratospheric cooling over the coming decades. Global average satellite observations of lower stratospheric temperatures exhibit no significant trends since the turn of the century. In contrast, an analysis of vertically resolved radiosonde measurements from 60 stations shows an increase of lower stratospheric temperature since the turn of the century at altitudes between 15 and 30 km and over most continents. Trend estimates are somewhat sensitive to homogeneity assessment choices, but all investigated radiosonde data sets suggest a change from late twentieth century cooling to early 21st century warming in the lower stratosphere.”

### **Water vapour trends mismatch**

Much of the warming in climate models derives not from GHG increases themselves but from water vapour feedbacks: extra warming induced by the projected accumulation of water vapour in the atmosphere after it warms due to CO<sub>2</sub>. But new evidence (Simpson I. et al. 2024) shows that models have over-projected increases in humidity.

“Water vapor in the atmosphere is expected to rise with warming because a warmer atmosphere can hold more moisture. However, over the last four decades, near-surface water vapor has not increased over arid and semi-arid regions. This is contrary to all climate model simulations in which it rises at a rate close to theoretical expectations, even over dry regions. This may indicate a major model misrepresentation of hydroclimate-related processes; models increase water vapor to satisfy the increased atmospheric demand, while this has not happened in reality.”

(Simpson et al. 2024)

While the models and observations matched over the 1988 to 2006 interval they diverge after that, directly contradicting model projections.

### Snow cover mismatch

According to the Rutgers University Snow Lab (undated) the Northern Hemisphere winter snow cover shows an increasing trend over time.

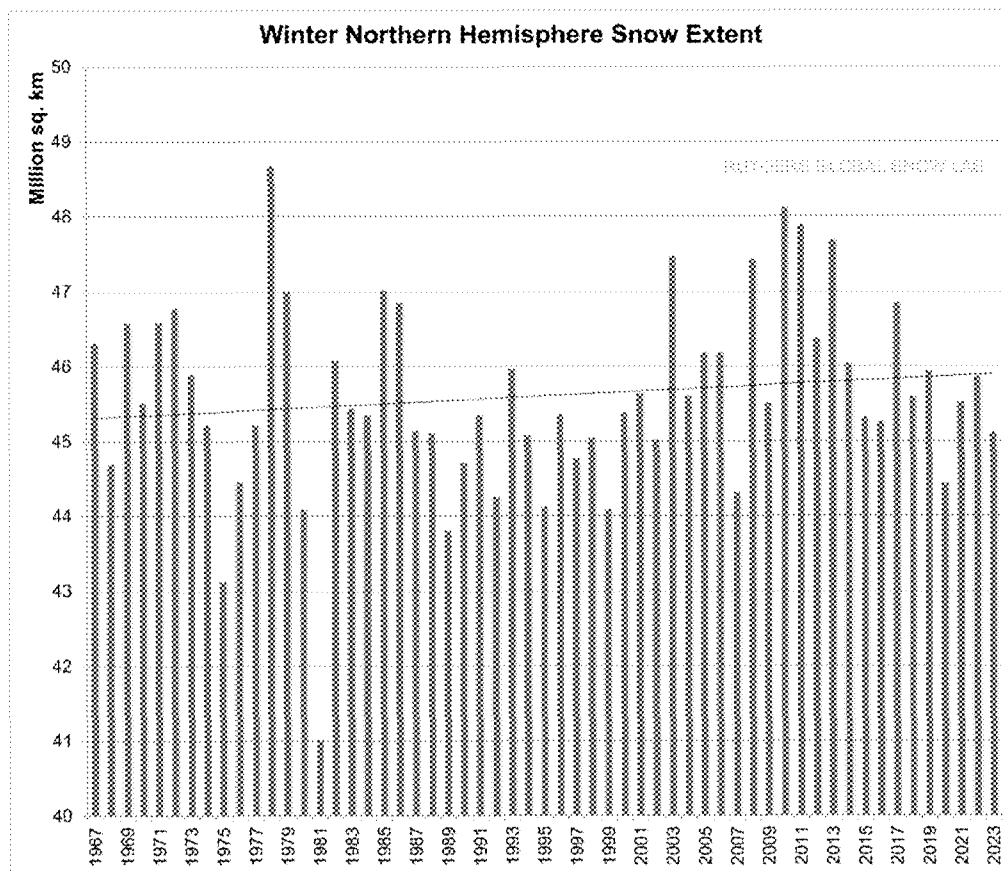


Figure 1.4.9: Northern Hemisphere Winter Snow extent. Source: [https://climate.rutgers.edu/snowcover/chart\\_seasonal.php?ui\\_set=nhl&ui\\_season=1](https://climate.rutgers.edu/snowcover/chart_seasonal.php?ui_set=nhl&ui_season=1) (February 24, 2024)

Models project declining Northern Hemisphere snow cover due to climate warming. But observations do not support this (Connolly et al. 2019).

**Observed changes in Northern Hemisphere snow cover from satellite records were compared to those predicted by all available Coupled Model Intercomparison Project Phase 5 ("CMIP5") climate models over the duration of the satellite's records, i.e., 1967–2018. A total of 196 climate model runs were analyzed (taken from 24 climate models). Separate analyses were conducted for the annual averages and for each of the seasons (winter, spring, summer, and autumn/fall). A longer record (1922–2018) for the spring season which**

combines ground-based measurements with satellite measurements was also compared to the model outputs. **The climate models were found to poorly explain the observed trends. While the models suggest snow cover should have steadily decreased for all four seasons, only spring and summer exhibited a long-term decrease, and the pattern of the observed decreases for these seasons was quite different from the modelled predictions. Moreover, the observed trends for autumn and winter suggest a long-term increase, although these trends were not statistically significant.**

Connolly et al. (2019), emphasis added.

**US Corn Belt**

One of the largest discrepancies between models and observations can be found when we test them in a region of particular importance to global food production: the U.S. Corn Belt. Fig. 1.4.10 shows the warming trends for summertime (June, July, August) for the U.S. 12-state Corn Belt (IN, IA, NE, ND, SD, MO, MN, WI, MI, OH, KS, NE) during 1973-2022. All 36 climate models (red) produced too much warming compared to observations (blue).

during 1973 to 2022.

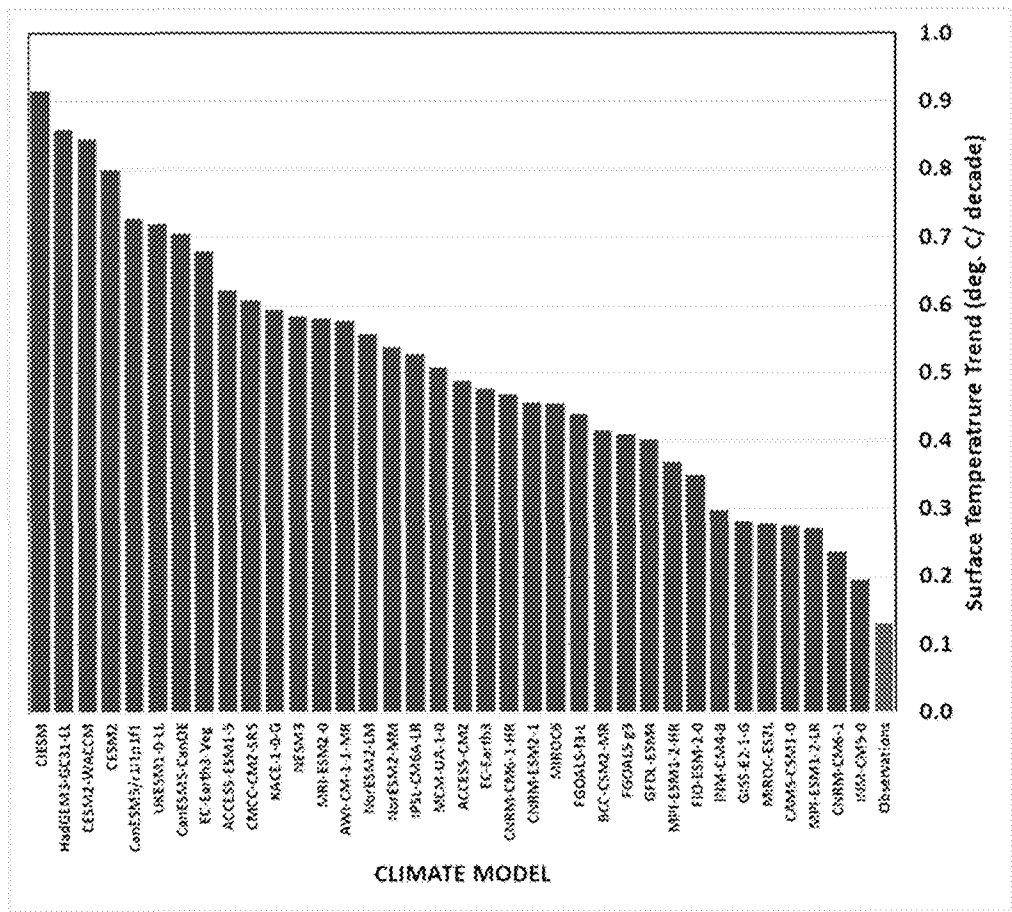


Figure 1.4.10: Modeled versus observed warming trends in the US corn belt.

As discussed in Chapter 3, the anticipated negative effects of increasing temperatures on U.S. corn yields have not materialized, which is in contrast to widely publicized studies proclaiming that theoretical future impacts are already being experienced (e.g. Seager et al., 2017).

In summary, climate models show warming biases in many aspects of their reproduction of the past few decades. They produce too much warming at the surface (except in the models with lowest ECS), too much warming in the lower-and mid-troposphere, too much amplification of warming aloft, too much stratospheric cooling, too much water vapor increase, too much snow loss, and too much warming in the corn belt. The IPCC has acknowledged some of these issues, buried the amplification problem and ignored others. The warm bias discussed here is consistent with independent evidence of model bias presented in Sections 1.5 (optimal fingerprinting) and 1.6 (measuring climate sensitivity). Given the persistent warm bias in so many key aspects of climate model performance, users are justified in assuming that projections of future warming are also very likely to be biased too warm.

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Philipona, R. et al., 2018: Radiosondes Show That After Decades of Cooling, the Lower Stratosphere Is Now Warming. *Journal of Geophysical Research: Atmospheres*, 123(22), 12509–512522, doi:10.1029/2018jd028901. <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2018JD028901>

Simpson, I et al. (2024) Observed humidity trends in dry regions contradict climate models. *Proceedings of the National Academy of Sciences* 2024 Vol. 121 No. 1 e2302480120 <https://www.pnas.org/doi/10.1073/pnas.2302480120>

Connolly et al. (2019) Northern Hemisphere Snow-Cover Trends (1967–2018): A Comparison between Climate Models and Observations *Geosciences* 2019, 9(3), 135 <https://www.mdpi.com/2076-3263/9/3/135>

Rutgers University Snow Lab (undated) <http://climate.rutgers.edu/snowcover/index.php>

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**From:** Roy Spencer [roywspencer@hotmail.com]  
**Sent:** 4/17/2025 11:17:32 AM  
**To:** Ross McKittrick [ross.mckittrick@gmail.com]; Travis Fisher [travis.scott.fisher@gmail.com]  
**CC:** Steven Koonin [steven.koonin@gmail.com]; John Christy [climatemanager60@gmail.com]  
**Subject:** Section 1.4.2 Can climate models reproduce the recent past?  
**Attachments:** 1.4.2 Can climate models reproduce the recent past [RS].docx

Attached. This is the minimum I think needs to be in this section. Of course, more could be added, but I think we need to stick to our strongest arguments, given the limited time available.

-Roy

---

**From:** Roy Spencer <roywspencer@hotmail.com>  
**Sent:** Wednesday, April 16, 2025 7:16 AM  
**To:** Ross McKittrick <ross.mckittrick@gmail.com>; Travis Fisher <travis.scott.fisher@gmail.com>  
**Cc:** Steven Koonin <steven.koonin@gmail.com>; John Christy <climatemanager60@gmail.com>  
**Subject:** Some Spencer inputs

I took it upon myself to write a preamble in **Section 1.3 Drivers of climate change** (attached), which seemed necessary to introduce some basic concepts.

Also attached are my initial submissions for **1.3.2** and **1.3.3**.

**NO references** added yet.

One of the things I believe we need to watch out for is *neglecting to come to conclusions along the way*... There is a tendency to get mired in the technical details without getting around to saying what each section might mean in eventual policy decisions related to the Endangerment Finding. In my experience, it is not possible to dumb-down this stuff too much. I suggest some sort of "Summary Boxes" with 1-2 simplified statements highlighting a main conclusion of each section that would have policy relevance.

-Roy

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**From:** Ross McKittrick <ross.mckittrick@gmail.com>  
**Sent:** Monday, April 14, 2025 1:37 PM  
**To:** Travis Fisher <travis.scott.fisher@gmail.com>  
**Cc:** Steven Koonin <steven.koonin@gmail.com>; John Christy <climatemanager60@gmail.com>; roywspencer@hotmail.com <roywspencer@hotmail.com>  
**Subject:** Re: Kickoff

Hi Travis

We developed the outline a bit further and assigned sections out yesterday. We'll keep you cc'd going forward.

Here is a Dropbox link that contains the current outline (also attached) which indicates who is working on each section

[https://www.dropbox.com/sc/1fo/wahx6lpwzu33m5vyri8x/ANTU1qAQJ-zXCFzP\\_gsJcOs?rlkey=l1z3qj9v46e1t5f4ywwxq7p8c&dl=0](https://www.dropbox.com/sc/1fo/wahx6lpwzu33m5vyri8x/ANTU1qAQJ-zXCFzP_gsJcOs?rlkey=l1z3qj9v46e1t5f4ywwxq7p8c&dl=0)

The link should give you all editing privileges.



I put folders in there for each of us. If the use of that Dropbox (which is on my own account) is acceptable for this project then we can share our work using it. Otherwise once we have an official Dropbox created we can transfer the material over to it.

Do you think it would be helpful to have a section specifically addressing the question of whether CO2 is a pollutant like CO, NOx, SOx, PM, etc.? If you want to add topics or suggest changes please do, the earlier the better as we begin filling out the contents.

Cheers,

Ross

On Mon, Apr 14, 2025 at 2:12 PM Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:

This is an excellent start! Can we move forward by iterating with this document for now? Please feel free to add whatever material you like, and I can collate if there are any simultaneous changes. I will leave the substance to you all because I view my role as a facilitator rather than a contributor, but please let me know how I can be most helpful.

Steve is correct that this document should be clear and understandable for non-experts. My understanding is that it should also be sufficiently technical and comprehensive to inform policymakers on all relevant aspects of the science.

One area I can help with might be targeting your work for the very brief window we have open at the moment. I am including a few lines verbatim below from key documents to highlight the areas of inquiry that are most relevant to the policymaking process. Of course, you all should make your own judgments about what to include versus what to leave out.

Here is a key section of the Clean Air Act, 202(a)(1): "The Administrator shall by regulation prescribe (and from time to time revise) in accordance with the provisions of this section, standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare. Such standards shall be applicable to such vehicles and engines for their useful life (as determined under subsection (d), relating to useful life of vehicles for purposes of certification), whether such vehicles and engines are designed as complete systems or incorporate devices to prevent or control such pollution."

Section 202 can be found [here](#).

Here is another key section of the Clean Air Act, section 302(g): "The term 'air pollutant' means any air pollution agent or combination of such agents, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and byproduct material) substance or matter which is emitted into or otherwise enters the ambient air. Such term includes any precursors to the formation of any air pollutant, to the extent the Administrator has identified such precursor or precursors for the particular purpose for which the term 'air pollutant' is used."

A threshold question raised in Justice Scalia's dissent in *Mass v. EPA* (which can be found [here](#)) is whether CO2 falls under the definition of an "air pollutant" under the Clean Air Act. The majority in *Mass v. EPA* found that *any* compound emitted into the ambient air fits the definition of "air pollutant," leading to a colorful footnote in the Scalia dissent ("It follows that everything airborne, from Frisbees to flatulence, qualifies as an 'air pollutant.' This reading of the statute defies common sense."). A scientific interpretation of this definition could be very helpful.

The next section in the statute is 302(h), which defines effects on welfare: "All language referring to effects on welfare includes, but is not limited to, effects on soils, water, crops, vegetation, manmade materials, animals,

wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants." Positive impacts, including fertilization effects and beneficial warming, seem to be within scope here.

Section 302 can be found [here](#).

As you all develop the draft, I encourage you to include as many citations to published materials as possible (links would work fine as placeholders). I have found this works better under a tight timeline than going back and looking for sources later. Please also feel free to task me with any research help you might need.

Best,  
Travis

On Fri, Apr 11, 2025 at 8:10 PM Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)> wrote:

I assume we're writing for non-experts. If so, some educating beyond the root questions is in order (it always helps if people feel smarter after reading).

So I've taken Ross' material, added some broader context, and cast it into the forcing/response/impact syllogism that most non-experts seem to get. The result is attached.

I think we can deal with the differences relative to 2009 in an appendix.

SEK

---

**From:** John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>

**Sent:** Friday, April 11, 2025 6:34 PM

**To:** Ross McKittrick <[ross.mckitrick@gmail.com](mailto:ross.mckitrick@gmail.com)>

**Cc:** Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>; [steven.koonin@gmail.com](mailto:steven.koonin@gmail.com); [roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)

**Subject:** Re: Kickoff

Excellent list Ross. Wildfires are a significant topic to be addressed.

John C.

Sent from my iPhone

On Apr 11, 2025, at 4:05 PM, Ross McKittrick <[ross.mckitrick@gmail.com](mailto:ross.mckitrick@gmail.com)> wrote:

The attached represents my summary of the most questions needing to be answered, which I think this group is capable of answering in the next couple of weeks. Probably lots of material already in hand.

On Fri, Apr 11, 2025 at 4:24 PM Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:

Gentlemen,

I can't thank you enough for taking this on under such a tight timeline. Let's use this thread to exchange information, links, etc., and as we move forward, I'll see about a document-sharing platform and a shared document to work on simultaneously.

Best,  
Travis

<DE.memo.outline.Apr.11.[RM].docx>

Climate models are the primary tool used to project future climate changes in response to increasing atmospheric levels of anthropogenic greenhouse gases. They provide the theoretical evidence underpinning energy policy changes, such as efforts to reduce carbon dioxide emissions. In order to determine the value of climate models for this purpose, it is reasonable to ask how well they have reproduced climate variations over the recent past, say the last half-century.

Computerized climate models are complex representations of the time-dependent behavior of the global atmosphere and ocean. They are extensions of weather forecast models that have been the basis for our daily weather forecasts since the late 1970s. But while weather forecast models take an initial state of the atmosphere and then project forward in time the evolving state of the atmosphere over several days, climate models instead are used to see how the average state of the atmosphere and ocean are altered over long periods of time (years, decades, or centuries) in response to anthropogenic forcing agents.

Of great concern is the fact that, after several decades of the climate modeling enterprise involving approximately two dozen models operated by research centers around the world, the range of future warming they produce in response to a hypothetical doubling of atmospheric CO<sub>2</sub> (2XCO<sub>2</sub>) extends over a factor of three. This range of disagreement between models has not changed for decades.

One might then reasonably ask: If climate models are based upon known physical principles (as is often claimed) and those model represent “settled” science, why do different climate modeling groups obtain results that vary over such wide ranges?

Problems with climate models are not just in their disagreement over the future, but also in their ability to replicate the recent past. This is illustrated in Fig. X1 with results from the latest (sixth) Climate Model Intercomparison Project (CMIP6, ref.) showing the linear warming trends for 1979 through 2023 as produced by models versus observations. To provide a fair test of the claims of the IPCC, only those models whose warming response to 2XCO<sub>2</sub> fall within the “highly likely” range of 2 to 5 deg. C of eventual future warming are shown.

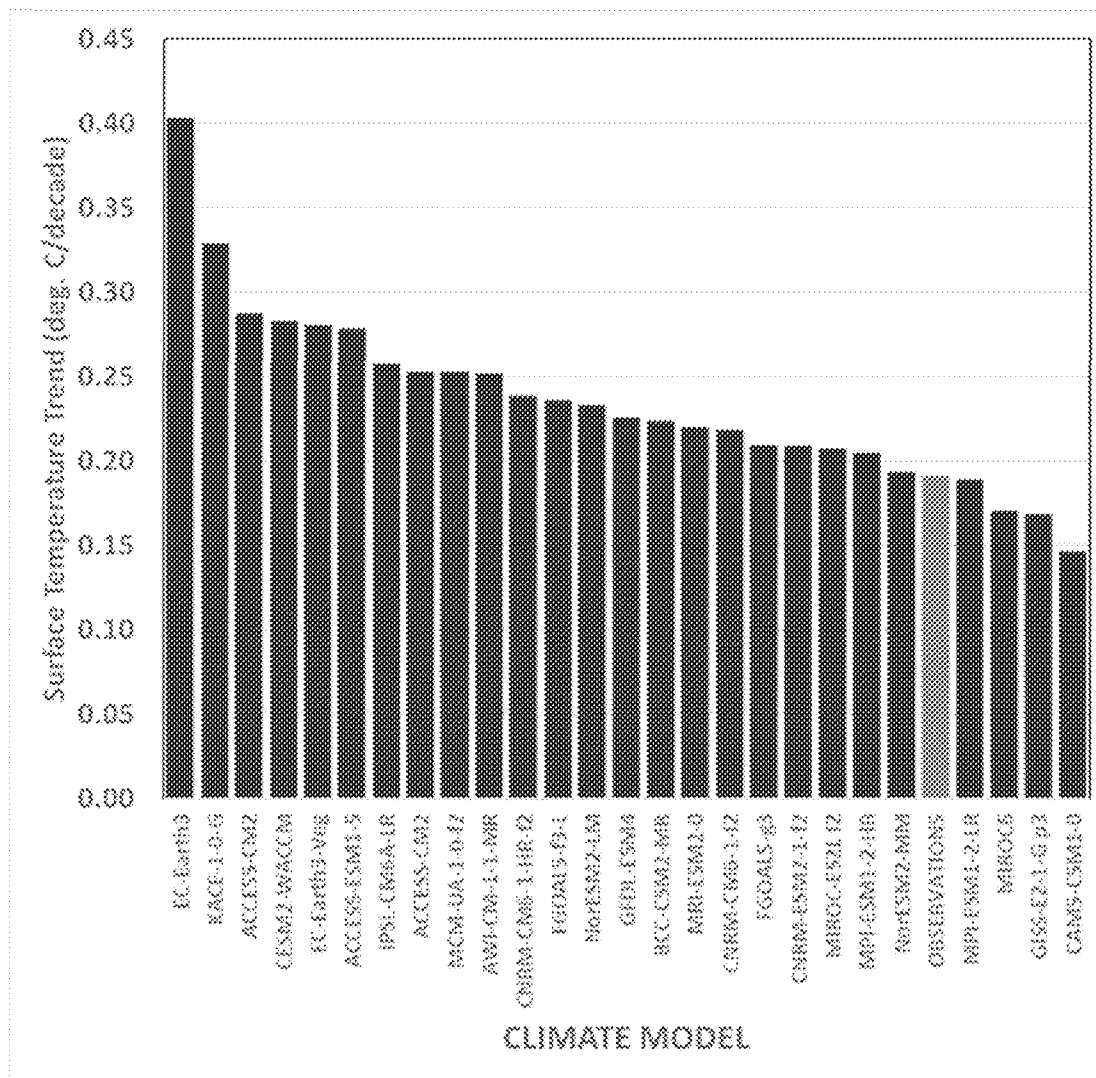


Fig. X1. The linear global-average surface warming trends 1979-2023 produced by those climate models the IPCC deems as most plausible (red bars) are almost all warmer than the observed warming trends (blue bar, the average of 5 widely used surface temperature datasets). [Data source: <https://climexp.knmi.nl/start.cgi> (accessed January 10, 2024)]

There are several reasons why 1979 was chosen as the starting date for comparison. First, we have had global satellite observations only since 1979 which provide important input into “reanalysis” models which take all available types of weather data to estimate conditions in regions where little to no conventional data had previously existed. Second, warming has been greatest since the 1970s. Third, the assumed radiative forcing of the climate system from increasing greenhouse gases has also been the greatest since the 1970s. And finally, the period since 1979 (~45 years) is sufficiently long to average out the noise caused by internal climate fluctuations such as El Nino, La Nina, and major volcanic eruptions.

In summary, the period since 1979 provides a robust test of climate models to see if the anticipated strong warming response to anthropogenic forcing has indeed been occurring. The results in Fig. X1 show that the climate models used to support energy policy decisions have, on average, been running too warm when compared to surface temperature observations.

The disparity between models and observations becomes somewhat worse when we examine the region of the atmosphere where the models project the greatest warming: the tropical mid- to upper-troposphere. This is where a “hot spot” has been expected to develop in response to anthropogenic global warming. As shown in Fig. X2, the average response of climate models has been to warm the tropical troposphere much too fast.

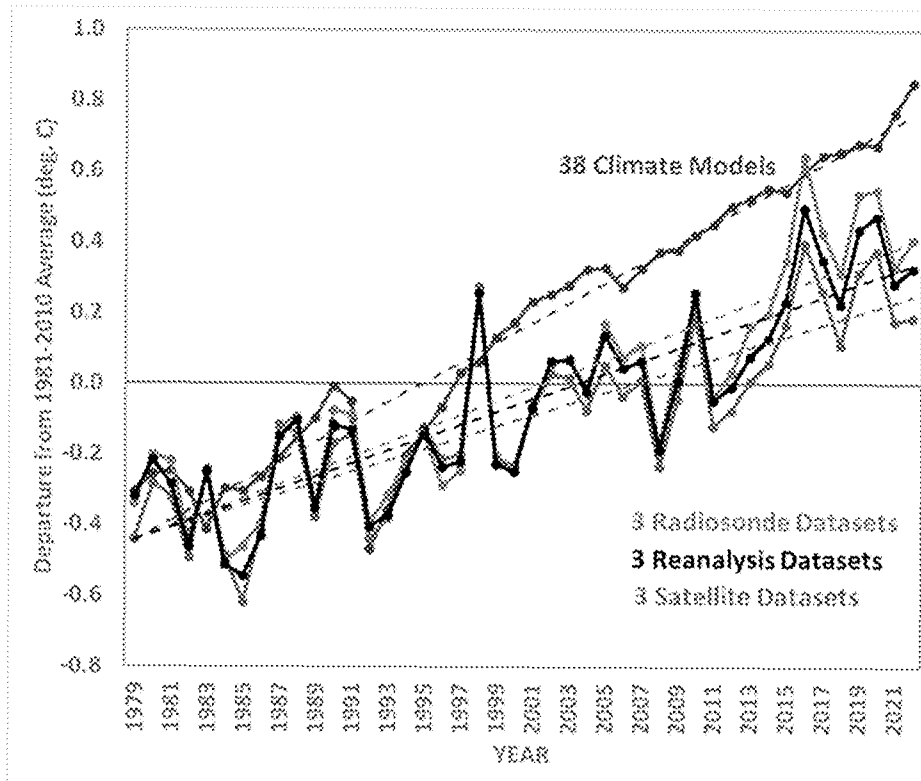


Fig. X2. Yearly global-average lower tropospheric temperatures (1979-2022) from the average of 38 climate models compared to those measured by the averages of 3 satellite datasets (blue), 3 reanalysis datasets (black), and 3 radiosonde (weather balloon) datasets (green). [Calculations based upon data from McKittrick & Christy (2020) and Blunden et al. (2023). Time series have been adjusted so their trend lines start at the same time, in 1979; this method of plotting can be shown to provide the earliest evidence of differences in datasets having different linear trends.

As demonstrated in Fig. X2, the models have diverged from the observations since approximately 2000. While the reasons for this are not clear, it is well known that the climate system we live in includes complex interactions between clouds, precipitation, water vapor, and radiation (both sunlight and infrared). Some of those processes are not even understood, let alone included in climate models. For example, the cloud and precipitation processes controlling the most abundant greenhouse gas in the atmosphere — water vapor — are still only poorly understood, especially when it comes to how those processes might change in response to warming.

An even larger discrepancy between models and observations exists when we test them in a region of particular importance to global food production: the U.S. Corn Belt. Fig. X.3 shows the warming trends for summertime (June, July, August) for the Corn Belt during 1973 to 2022.

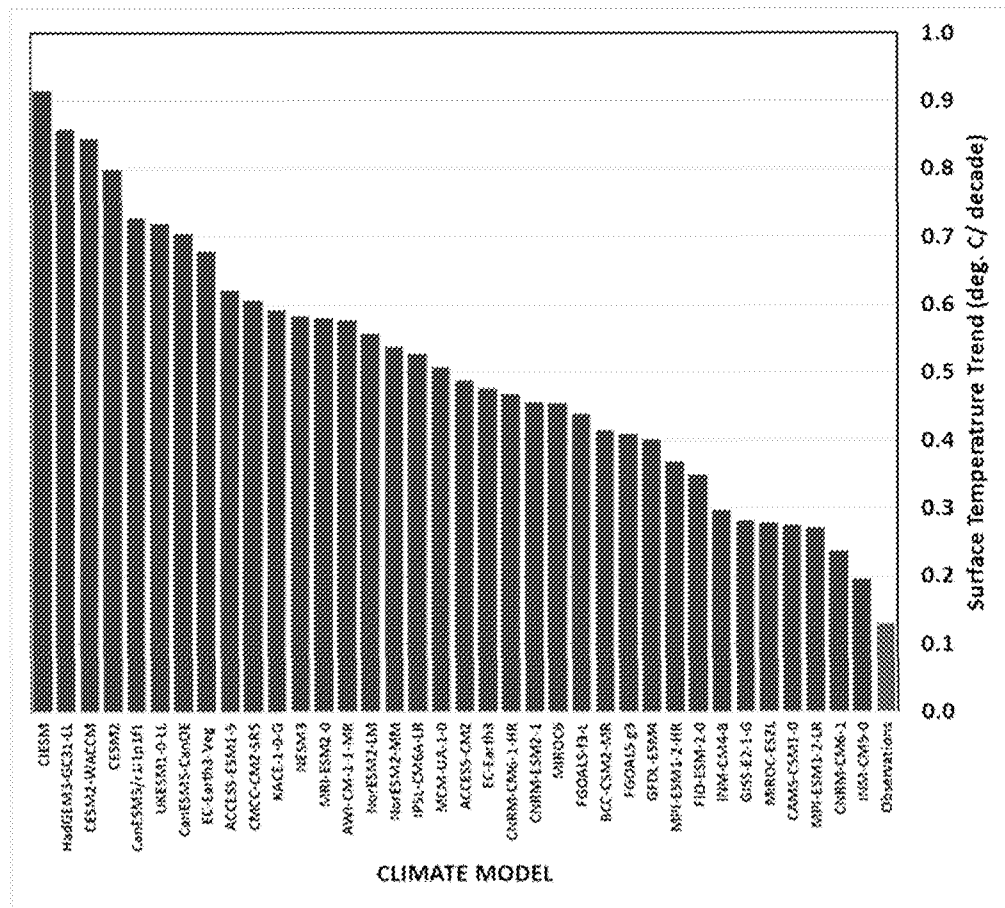


Fig. X3. As in Fig. X1, but for the U.S. 12-state Corn Belt (IN, IA, NE, ND, SD, MO, MN, WI, MI, OH, KS, NE) in summer during 1973-2022, showing that all 36 climate models (red) produced too much warming compared to observations (blue).

As discussed in Chapter 3, the anticipated negative effects of increasing temperatures on U.S. corn yields have not materialized, which is in contrast to widely publicized studies proclaiming that theoretical future impacts are already being experienced (e.g. Seager et al., 2017).

Given these rather large discrepancies between models and observations for the recent past, it is clear that global climate models are of questionable value for projecting future climate change.

---

**From:** Steven Koonin <steven.koonin@gmail.com>  
**Sent:** Sunday, April 27, 2025 9:35 PM  
**To:** Ross McKittrick  
**Cc:** Judith Curry; Roy Spencer; John Christy; Travis Fisher  
**Subject:** Re: Ch 6 Attribution

Right- they fail on both falsifiability AND “risky” predictions.

Popper would be appalled.

Steven E. Koonin

On Apr 27, 2025, at 16:04, Ross McKittrick <ross.mckittrick@gmail.com> wrote:

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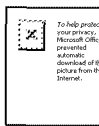
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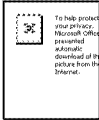
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**From:** John Christy [climateman60@gmail.com]  
**Sent:** 4/27/2025 11:35:18 PM  
**To:** Judith Curry [curry.judith@gmail.com]  
**CC:** Steve Koonin [steven.koonin@gmail.com]; Ross McKittrick [ross.mckittrick@gmail.com]; Roy Spencer [roywspencer@hotmail.com]; Travis Fisher [travis.scott.fisher@gmail.com]  
**Subject:** Re: Ch 6 Attribution

Ross

This can go in my JRC\_Figures folder.

Attached is an update of Fig. 20 from Mass et al. 2024. This shows that without 2021, there is actually a downward trend in the area of the Pacific NW that has experienced record high temperatures, again showing the event was a fluke and not part of a trend.

I use 6-yr periods because 6 divides into 126 years evenly, but whatever is chosen will make the point. The 5 most extensive sextads (is that a thing?) occurred prior to 1964.

John C.

John Christy  
Director, Earth System Science Center  
Professor, Atmos and Earth Science  
Alabama State Climatologist  
The University of Alabama in Huntsville  
climateman60@gmail.com

## PacNW Area with All Time Hottest Day per 6-year period

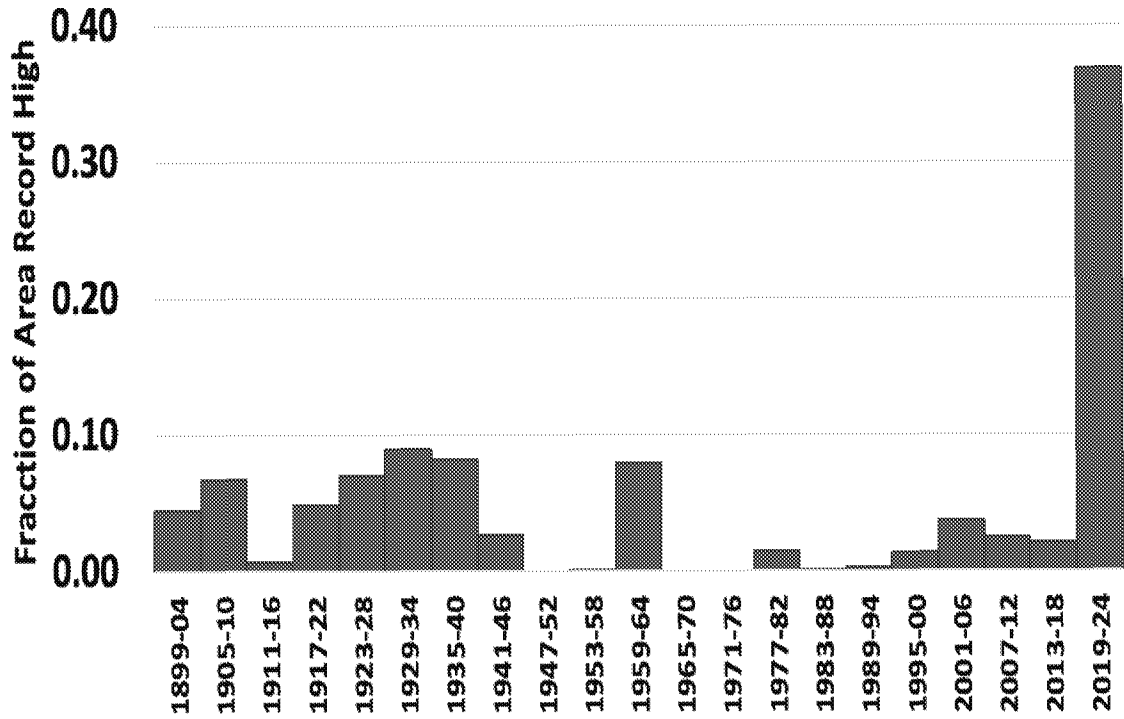
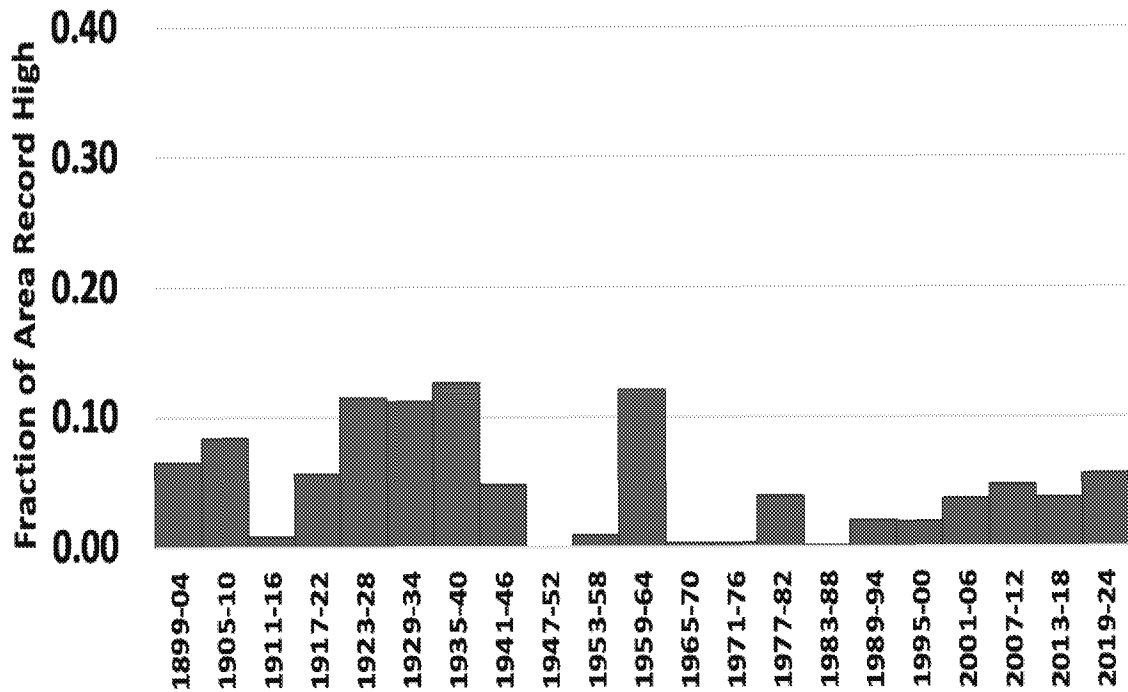


Fig. 20  
Mass et al.  
2024 for  
PacNW  
with  
update to  
2024

## PacNW as above w/o 2021



On Apr 27, 2025, at 6:13 PM, Judith Curry <curry.judith@gmail.com> wrote:

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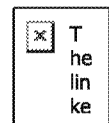
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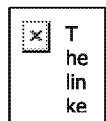
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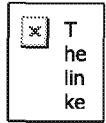
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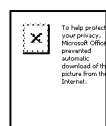
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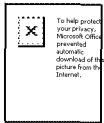
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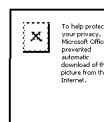
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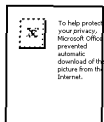
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your privacy,  
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prevented  
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On 2021 heat wave, don't forget Mass et al 2024 where we showed the classic black swan case and that models predict a lessening of this type of pattern in the future. On the unusual nature, the tropospheric 5-day column temperature in PacNW was the hottest anomaly of any grid for all summer 5-day anomalies in 46 years in the NH. That means it was the hottest out of more than 4 million realizations.

John C.

Sent from my iPhone

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**Sent:** Sunday, April 27, 2025 1:32 PM  
**To:** Steven Koonin  
**Cc:** Ross McKittrick; Roy Spencer; John Christy; Travis Fisher  
**Subject:** Re: Ch 6 Attribution

Well nothing in a complex system is readily falsifiable. In any event, attribution is rarely regarded as deterministic. I'm thinking of including a para (in section 1) on the difficulties of establishing causality in a complex, nonlinear system.

On Sun, Apr 27, 2025 at 10:06 AM Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)> wrote:

The strongest criticism of event attribution work is that it's not science, since it's not falsifiable. We should lead with that.

All of the rest is detail.

Steven Koonin

On Apr 27, 2025, at 09:22, Judith Curry <[curry.judith@gmail.com](mailto:curry.judith@gmail.com)> wrote:

Thx, pls send. the 2021 HW case is an excellent one, there was actually one good attribution analysis on this that used ECMWF model in forecast mode with pre-industrial vs current CO2 - surprise, the heat wave was 2F warmer with current CO2 than preindustrial.

attribution of individual events is a huge issue, this is driving dozens of lawsuits. I think we need to assess this

On Sun, Apr 27, 2025 at 9:17 AM Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:

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On Sun, Apr 27, 2025 at 11:31 AM Judith Curry <[curry.judith@gmail.com](mailto:curry.judith@gmail.com)> wrote:

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## 6 Uncertainties in the Analysis of Attribution

### 6.1 Introduction

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IPCC statement on challenges (ross' text)

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## 6.2 Methods

Ross' text (but shortened)

Some additional stuff

## 6.3 Detection and attribution of global warming

Relevant text from Ross

Additional text re natural climate variability (esp solar, great Pacific Climate Shift) and climate model inadequacies

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6.4.1 Global analysis (selected examples, maybe hurricanes)

6.4.2 Attribution of individual extreme events (heat waves, extreme rainfall)

## 6.5 Summary

-

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Judith Curry, President

CFAN - Climate Forecast Applications Network

Reno, NV USA

[curry.judith@cfanclimate.com](mailto:curry.judith@cfanclimate.com) | +1.404.803.2012

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--



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**From:** Steven Koonin <steven.koonin@gmail.com>  
**Sent:** Sunday, April 27, 2025 1:07 PM  
**To:** Judith Curry  
**Cc:** Ross McKittrick; Roy Spencer; John Christy; Travis Fisher  
**Subject:** Re: Ch 6 Attribution

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All of the rest is detail.

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To help protect  
your privacy,  
Outlook prevented  
automatic  
download of this  
picture from the  
Internet.

Judith Curry, President

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[curry.judith@cfanclimate.com](mailto:curry.judith@cfanclimate.com) | +1.404.803.2012

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**From:** Judith Curry <curry.judith@gmail.com>  
**Sent:** Sunday, April 27, 2025 12:23 PM  
**To:** Ross McKittrick  
**Cc:** Roy Spencer; John Christy; Travis Fisher; Steven Koonin  
**Subject:** Re: Ch 6 Attribution

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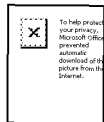
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Judith Curry, President  
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[curry.judith@cfanclimate.com](mailto:curry.judith@cfanclimate.com) | +1.404.803.2012  
<http://www.cfanclimate.net>



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**From:** Ross McKittrick <ross.mckittrick@gmail.com>  
**Sent:** Sunday, April 27, 2025 12:18 PM  
**To:** Judith Curry  
**Cc:** Roy Spencer; John Christy; Travis Fisher; Steven Koonin  
**Subject:** Re: Ch 6 Attribution

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**From:** Judith Curry <curry.judith@gmail.com>  
**Sent:** Sunday, April 27, 2025 11:31 AM  
**To:** Roy Spencer; John Christy; Judith Curry; Ross McKittrick; Travis Fisher; Steven Koonin  
**Subject:** Ch 6 Attribution

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### 6.5 Summary

-

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**From:** Roy Spencer <roywspencer@hotmail.com>  
**Sent:** Monday, April 21, 2025 4:23 PM  
**To:** Travis Fisher; Ross McKitrick  
**Cc:** John Christy; Steven Koonin; Judith Curry  
**Subject:** RE: legal strategies

We sure live in interesting times.  
-Roy

Sent from my Verizon, Samsung Galaxy smartphone

----- Original message -----

From: Travis Fisher <travis.scott.fisher@gmail.com>  
Date: 4/21/25 3:16 PM (GMT-06:00)  
To: Ross McKitrick <ross.mckitrick@gmail.com>  
Cc: John Christy <climateman60@gmail.com>, "Roy W. Spencer" <roywspencer@hotmail.com>, Steven Koonin <steven.koonin@gmail.com>, Judith Curry <curry.judith@gmail.com>  
Subject: Re: legal strategies

Thanks, Ross. I think the plan is to make a two-pronged argument (covering the strictly legal case and updating/revisiting the scientific underpinnings).

On Mon, Apr 21, 2025 at 3:49 PM Ross McKitrick <[ross.mckitrick@gmail.com](mailto:ross.mckitrick@gmail.com)> wrote:

This essay by Steve Milloy provides what seems to me a good explanation of why the Admin may want to move on the EF without a science paper  
<https://issuesinsights.com/2025/04/21/no-due-process-for-illegal-regulations/>

In brief, they would leverage West Virginia vs EPA (Major Question doctrine) to argue that notwithstanding Mass vs EPA the EPA never had regulatory authority over GHGs so the EF was illegal.

It is more complex to argue that the science since 2010 invalidates the original EF. The danger is the Admin would implicitly be treating the original EF as legal. Given that it will likely go to SCOTUS the goal is to arrive there on the most favourable legal issue not a potentially weak issue concerning how a rule change was pursued. The Major Question doctrine appears to be favorable grounds to argue on.

---

**From:** Travis Fisher <travis.scott.fisher@gmail.com>  
**Sent:** Monday, April 21, 2025 4:16 PM  
**To:** Ross McKittrick  
**Cc:** John Christy; Roy W. Spencer; Steven Koonin; Judith Curry  
**Subject:** Re: legal strategies

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**Sent:** Monday, April 21, 2025 3:49 PM  
**To:** Travis Fisher; John Christy; Roy W. Spencer; Steven Koonin; Judith Curry  
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**From:** Roy Spencer <roywspencer@hotmail.com>  
**Sent:** Friday, April 25, 2025 5:40 PM  
**To:** Ross McKittrick; Judith Curry  
**Cc:** John Christy; Travis Fisher; Steve Koonin  
**Subject:** RE: Apr 20 update

Let me know what sections I can contribute to.  
-Roy

Sent from my Verizon, Samsung Galaxy smartphone

----- Original message -----

From: Ross McKittrick <ross.mckittrick@gmail.com>  
Date: 4/25/25 3:50 PM (GMT-06:00)  
To: Judith Curry <curry.judith@gmail.com>  
Cc: John Christy <climateman60@gmail.com>, Travis Fisher <travis.scott.fisher@gmail.com>, Roy Spencer <roywspencer@hotmail.com>, Steve Koonin <steven.koonin@gmail.com>  
Subject: Re: Apr 20 update

Attached is what I had written earlier, with a paragraph inserted (red) by John. Can you take a crack at integrating it with your material?  
Ross

On Fri, Apr 25, 2025 at 4:44 PM Judith Curry <curry.judith@gmail.com> wrote:  
I'm out of the loop on the climate sensitivity chapter, but i have a lot of material on this which may be useful (attached)

On Fri, Apr 25, 2025 at 9:16 AM John Christy <climateman60@gmail.com> wrote:  
Ross

I believe you put together section 4 Climate. Sensitivity? I think we should take advantage of the IPCC AR6 Fig 3.8 (sent earlier) and insert it somewhere in this section. I think that HadGM is really a hoot as it had the strongest aerosol cooling and almost the hottest GHG warming, but, magically, ended up "just right". Anyway, something like this.

The uncertainty in modeled responses to specified aerosol and GHG forcings is indicated in Fig. 3.8 IPCC AR6 in which the historical temperature response from 1850-1900 to 2010-2019 is generated. The models' temperature responses to aerosol forcing varies from -1.0 to +0.1 °C (a range of 100% from the mean) and to GHG forcing of +1.0 to +2.2 °C (a range of 37% from the mean) as each model attempts to reach the pre-assigned target represented as the sum of the responses which is +1.0 °C. This wide range of responses to specified forcing given by the AR6 models (only 13 were used in Fig. 3.8) indicates physical processes within

the models are based on very different formulations (parameterizations) which are thus of questionable physical meaning.

John C.

On Thu, Apr 24, 2025 at 5:11 PM John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)> wrote:  
Thanks Travis. I did not know things could move that quickly in the government.

John C.

John Christy  
Director, Earth System Science Center  
Professor, Atmos and Earth Science  
Alabama State Climatologist  
The University of Alabama in Huntsville  
[climateman60@gmail.com](mailto:climateman60@gmail.com)

On Apr 24, 2025, at 5:04 PM, Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:

Great news!

The Secretary just told me our new deadline is May 28th. I feel pretty strongly that this is a firm and final deadline, but it also feels like the best case scenario because we have renewed buy-in that EPA will wait for this work and include it in its rulemaking.

Please let me know how I can support your work. I've been intentionally hands-off so far, but I want you to feel free to assign research, drafting, or editing duties to me as needed.

Ross suggested we increase our coordination with EPA, particularly the legal team drafting the rulemaking. If you want to be included in those conversations, please let me know. But I'm also happy to handle the legal and policy issues if you'd rather not be involved in that nexus. The goal would be to make sure policymakers get your input on all the scientific questions they feel are relevant.

As you all get onboarded in various ways, please connect with me (ideally by phone) if you have any questions or if something about the offer or paperwork doesn't seem quite right. I'll work with the folks at DOE to make sure everything turns out the way you want.

Finally, the Secretary wanted me to send his thanks and appreciation for taking on this work. Thank you!

Best,  
Travis

On Thu, Apr 24, 2025 at 3:05 PM Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:  
Hi all,

I've been waiting to chime in because I was hoping for more certainty by now, but the only thing I have to add is that Ross has won his fight with the White House about joining via contract (even though Ross is an evil foreigner from a strange place where people are conspicuously nice). It took a call from the Secretary, but we prevailed. (Ross, you'll be hearing more very soon.)

I can also confirm all the other information that was shared so far by Ross and John. The Secretary wants a thorough report that you all are proud of. If the EPA declines to use it, or demands an April 30 deadline, so be it, but the Secretary will move forward with the full report in any case.

The remaining variable (for me, anyway) is what to offer EPA if they demand a document before you all are comfortable putting your names on it. My preference is to supply them with something, even if it's in rough shape and unfit for attribution. Please think about what you all might want to do in that case because I think it's still a strong possibility. The main argument against supplying something in that case is that it would essentially be an early draft of the report Secretary Wright wants, so think about ways to differentiate the documents, etc.

Thanks again for your hard work under an impossible deadline. I'll update you all as soon as we get a new (interim/rushed) deadline from EPA. It's my understanding that the Secretary initially asked for May 15, but it's possible he will ask for even more time after hearing directly from Ross about how helpful it would be to get another full month (or more). Wright and Zeldin are traveling together today, so we should have an answer soon.

Best,  
Travis

On Thu, Apr 24, 2025 at 1:12 PM John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)> wrote:  
All

My plane was late, so I just missed the meeting with Ross, Travis and the Secretary, but did meet with Ross and Travis for over an hour immediately afterward.

Ross's summary below is what I gathered from our meeting. My sense was that the difficulties being encountered are related to a lack of communication between EPA and DoE, and even the White House, aided by the general sand-in-the-gears that some career federal employees are supplying. As Ross indicates we may have two phases - a generic, "un-authored" document fairly soon and a complete "authored" document later. The purpose of these documents is still murky as the challenge to the EF may or may not use them, but the Secretary absolutely wants the products. I mentioned again that an authored document would be a real commitment because we would have to deal with answering criticism as well as dealing with personal attacks for months.

As Ross said, we should be hearing more very soon.

John C.



John Christy  
Director, Earth System Science Center  
Professor, Atmos and Earth Science  
Alabama State Climatologist  
The University of Alabama in Huntsville  
[climatemanager60@gmail.com](mailto:climatemanager60@gmail.com)

On Apr 23, 2025, at 7:49 AM, Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:

Thanks Steve and Roy. I have a few wording suggestions but am off to a meeting so I'll write later.

Travis and I had a meeting with Secretary Wright yesterday. I'll let Travis provide a more complete summary but my takeaway was:

- Chris was unaware of the problems we had encountered until we briefed him
- The current deadline and lack of direction conflicts with his vision of the project
- He is going to try to get more time for us; and there might be an option which gives us a lot more time
- He wants us to have the time and support to produce a substantive document with our names on it. He understands why if we are held to an Apr 30 deadline we would not be able to do that.
- More to come as he digs into the situation.

On Wed, Apr 23, 2025 at 6:59 AM Roy Spencer  
<[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)> wrote:

All:

I've made some edits to Steve's document (attached).

The first (rather large) edit has to do with the implication that climate change is only due to changes in the radiative energy balance of the Earth, which I (and Dick Lindzen) disagree with. How to handle this, though, is not that obvious to me. I realize we are addressing human influences on climate, but I don't think we should accept such an anthropocentric view of climate change at the outset... This comes up later, too, in the discussion of global radiative forcing since the 1700s... We have no clue what kinds of other energy imbalances (either at the surface or at top-of-atmosphere) might have been occurring due to Nature since the 1700s.

Again, I'm open to suggestions. Maybe such issues are not necessary to mention if even the putative human forcings lead to non-damaging impacts (?)

-Roy

**From:** Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>  
**Sent:** Tuesday, April 22, 2025 11:05 PM  
**To:** 'Ross McKittrick' <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>; 'Travis Fisher' <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>; 'John Christy' <[climateman60@gmail.com](mailto:climateman60@gmail.com)>; 'Roy W. Spencer' <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>; 'Judith Curry' <[curry.judith@gmail.com](mailto:curry.judith@gmail.com)>  
**Subject:** RE: Apr 20 update

Attached is my take on an integrated Part 1 (together with a modest introduction). I've incorporated relevant material from others.

1. See if you like the narrative arc, which to me feels pretty natural. Note that the subsections turned out to have somewhat different titles
2. Most problematic for me is the technical level. Trying to avoid too much "Climate 101", but some of the material, particularly in Parts 2 and 3 will get pretty technical
3. I'm feeling like it lacks punch. "So what" is missing
4. Obviously, the mechanics need work. Formatting, citations, better figures, ...
5. If you all aren't too dissatisfied with this, I'd propose doing a similar job on Part 2 in the next few days.

SEK

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**From:** Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>  
**Sent:** Sunday, April 20, 2025 8:09 PM  
**To:** Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>; John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>; Roy W. Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>; Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>; Judith Curry <[curry.judith@gmail.com](mailto:curry.judith@gmail.com)>  
**Subject:** Apr 20 update

I've created a new dropbox folder called April 20 version which contains the revised outline, the associated chapters and the reference list for all my sections. I took the documents done prior to this point and renumbered the files and sections accordingly.

The new outline is (bold denotes draft posted)

Part I: Human influence on the climate

- 1 Components of anthropogenic radiative forcing and their history to date
- 2 The carbon cycle and future emission scenarios**
- 3 Aerosols and the uncertainties associated with them

Part II: Climate response to anthropogenic influence

- 4 Measuring climate sensitivity to CO2 doubling**
- 5 Models versus observations in recent past**
- 6 Uncertainties in analysis of attribution**
- 7 Evidence on trends and attributable changes in extreme weather**
- 8 Sea level rise

Part III: Impacts on ecosystems and society

- 9 Managing risks of extreme weather**
- 10 Mortality risk from extreme heat and cold
- 11 Climate change and US agriculture**
- 12 Climate change and global greening
- 13 Climate change and economic growth**
- 14 Estimates of the Social Cost of Carbon
- 15 US vehicle-based CO2 emissions and the global climate

Steve: can you draft 1 & 3?

Judy: hoping you can do 8, 10 and 14 (I have info on 14 as well.)

John I think you have something on 15.

Cheers,  
Ross



--  
Judith Curry, President  
CFAN - Climate Forecast Applications Network  
Reno, NV USA  
[curry.judith@cfanclimate.com](mailto:curry.judith@cfanclimate.com) | +1.404.803.2012  
<http://www.cfanclimate.net>

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**From:** Ross McKittrick [ross.mckittrick@gmail.com]  
**Sent:** 4/25/2025 8:49:48 PM  
**To:** Judith Curry [curry.judith@gmail.com]  
**CC:** John Christy [climateman60@gmail.com]; Travis Fisher [travis.scott.fisher@gmail.com]; Roy Spencer [roywspencer@hotmail.com]; Steve Koonin [steven.koonin@gmail.com]  
**Subject:** Re: Apr 20 update  
**Attachments:** 1.6.2.Empi.ECS.Apr18[JC].docx

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On Fri, Apr 25, 2025 at 9:16 AM John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)> wrote:  
Ross

I believe you put together section 4 Climate. Sensitivity? I think we should take advantage of the IPCC AR6 Fig 3.8 (sent earlier) and insert it somewhere in this section. I think that HadGM is really a hoot as it had the strongest aerosol cooling and almost the hottest GHG warming, but, magically, ended up "just right". Anyway, something like this.

The uncertainty in modeled responses to specified aerosol and GHG forcings is indicated in Fig. 3.8 IPCC AR6 in which the historical temperature response from 1850-1900 to 2010-2019 is generated. The models' temperature responses to aerosol forcing varies from -1.0 to +0.1 °C (a range of 100% from the mean) and to GHG forcing of +1.0 to +2.2 °C (a range of 37% from the mean) as each model attempts to reach the pre-assigned target represented as the sum of the responses which is +1.0 °C. This wide range of responses to specified forcing given by the AR6 models (only 13 were used in Fig. 3.8) indicates physical processes within the models are based on very different formulations (parameterizations) which are thus of questionable physical meaning.

John C.

On Thu, Apr 24, 2025 at 5:11 PM John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)> wrote:  
Thanks Travis. I did not know things could move that quickly in the government.

John C.

John Christy  
Director, Earth System Science Center  
Professor, Atmos and Earth Science  
Alabama State Climatologist  
The University of Alabama in Huntsville  
[climateman60@gmail.com](mailto:climateman60@gmail.com)

On Apr 24, 2025, at 5:04 PM, Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:

Great news!

The Secretary just told me our new deadline is May 28th. I feel pretty strongly that this is a firm and final deadline, but it also feels like the best case scenario because we have renewed buy-in that EPA will wait for this work and include it in its rulemaking.

Please let me know how I can support your work. I've been intentionally hands-off so far, but I want you to feel free to assign research, drafting, or editing duties to me as needed.

Ross suggested we increase our coordination with EPA, particularly the legal team drafting the rulemaking. If you want to be included in those conversations, please let me know. But I'm also happy to handle the legal and policy issues if you'd rather not be involved in that nexus. The goal would be to make sure policymakers get your input on all the scientific questions they feel are relevant.

As you all get onboarded in various ways, please connect with me (ideally by phone) if you have any questions or if something about the offer or paperwork doesn't seem quite right. I'll work with the folks at DOE to make sure everything turns out the way you want.

Finally, the Secretary wanted me to send his thanks and appreciation for taking on this work. Thank you!

Best,  
Travis

On Thu, Apr 24, 2025 at 3:05 PM Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:

Hi all,

I've been waiting to chime in because I was hoping for more certainty by now, but the only thing I have to add is that Ross has won his fight with the White House about joining via contract (even though Ross is an evil foreigner from a strange place where people are conspicuously nice). It took a call from the Secretary, but we prevailed. (Ross, you'll be hearing more very soon.)

I can also confirm all the other information that was shared so far by Ross and John. The Secretary wants a thorough report that you all are proud of. If the EPA declines to use it, or demands an April 30 deadline, so be it, but the Secretary will move forward with the full report in any case.

The remaining variable (for me, anyway) is what to offer EPA if they demand a document before you all are comfortable putting your names on it. My preference is to supply them with something, even if it's in rough shape and unfit for attribution. Please think about what you all might want to do in that case because I think it's still a strong possibility. The main argument against supplying something in that case is that it would essentially be an early draft of the report Secretary Wright wants, so think about ways to differentiate the documents, etc.

Thanks again for your hard work under an impossible deadline. I'll update you all as soon as we get a new (interim/rushed) deadline from EPA. It's my understanding that the Secretary initially asked for May 15,

but it's possible he will ask for even more time after hearing directly from Ross about how helpful it would be to get another full month (or more). Wright and Zeldin are traveling together today, so we should have an answer soon.

Best,  
Travis

On Thu, Apr 24, 2025 at 1:12 PM John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)> wrote:  
All

My plane was late, so I just missed the meeting with Ross, Travis and the Secretary, but did meet with Ross and Travis for over an hour immediately afterward.

Ross's summary below is what I gathered from our meeting. My sense was that the difficulties being encountered are related to a lack of communication between EPA and DoE, and even the White House, aided by the general sand-in-the-gears that some career federal employees are supplying. As Ross indicates we may have two phases - a generic, "un-authored" document fairly soon and a compete "authored" document later. The purpose of these documents is still murky as the challenge to the EF may or may not use them, but the Secretary absolutely wants the products. I mentioned again that an authored document would be a real commitment because we would have to deal with answering criticism as well as dealing with personal attacks for months.

As Ross said, we should be hearing more very soon.

John C.

John Christy  
Director, Earth System Science Center  
Professor, Atmos and Earth Science  
Alabama State Climatologist  
The University of Alabama in Huntsville  
[climateman60@gmail.com](mailto:climateman60@gmail.com)

On Apr 23, 2025, at 7:49 AM, Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:

Thanks Steve and Roy. I have a few wording suggestions but am off to a meeting so I'll write later. Travis and I had a meeting with Secretary Wright yesterday. I'll let Travis provide a more complete summary but my takeaway was:

- Chris was unaware of the problems we had encountered until we briefed him
- The current deadline and lack of direction conflicts with his vision of the project
- He is going to try to get more time for us; and there might be an option which gives us a lot more time
- He wants us to have the time and support to produce a substantive document with our names on it. He understands why if we are held to an Apr 30 deadline we would not be able to do that.
- More to come as he digs into the situation.

On Wed, Apr 23, 2025 at 6:59 AM Roy Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)> wrote:  
All:

I've made some edits to Steve's document (attached).

The first (rather large) edit has to do with the implication that climate change is only due to changes in the radiative energy balance of the Earth, which I (and Dick Lindzen) disagree with. How to handle this, though, is not that obvious to me. I realize we are addressing human influences on climate, but I don't think we should accept such an anthropocentric view of climate change at the outset... This comes up later, too, in the discussion of global radiative forcing since the 1700s... We have no clue what kinds of other energy imbalances (either at the surface or at top-of-atmosphere) might have been occurring due to Nature since the 1700s.

Again, I'm open to suggestions. Maybe such issues are not necessary to mention if even the putative human forcings lead to non-damaging impacts (?)

-Roy

---

**From:** Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>

**Sent:** Tuesday, April 22, 2025 11:05 PM

**To:** 'Ross McKittrick' <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>; 'Travis Fisher' <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>; 'John Christy' <[climateman60@gmail.com](mailto:climateman60@gmail.com)>; 'Roy W. Spencer' <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>; 'Judith Curry' <[curry.judith@gmail.com](mailto:curry.judith@gmail.com)>

**Subject:** RE: Apr 20 update

Attached is my take on an integrated Part 1 (together with a modest introduction). I've incorporated relevant material from others.

1. See if you like the narrative arc, which to me feels pretty natural. Note that the subsections turned out to have somewhat different titles
2. Most problematic for me is the technical level. Trying to avoid too much "Climate 101", but some of the material, particularly in Parts 2 and 3 will get pretty technical
3. I'm feeling like it lacks punch. "So what" is missing
4. Obviously, the mechanics need work. Formatting, citations, better figures, ...
5. If you all aren't too dissatisfied with this, I'd propose doing a similar job on Part 2 in the next few days.

SEK

---

**From:** Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>

**Sent:** Sunday, April 20, 2025 8:09 PM

**To:** Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>; John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>; Roy W. Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>; Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>; Judith Curry <[curry.judith@gmail.com](mailto:curry.judith@gmail.com)>

**Subject:** Apr 20 update

I've created a new dropbox folder called April 20 version which contains the revised outline, the associated chapters and the reference list for all my sections. I took the documents done prior to this point and renumbered the files and sections accordingly.

The new outline is (bold denotes draft posted)

Part I: Human influence on the climate

- 1 Components of anthropogenic radiative forcing and their history to date
- 2 The carbon cycle and future emission scenarios**
- 3 Aerosols and the uncertainties associated with them

Part II: Climate response to anthropogenic influence

- 4 Measuring climate sensitivity to CO2 doubling**
- 5 Models versus observations in recent past**
- 6 Uncertainties in analysis of attribution**
- 7 Evidence on trends and attributable changes in extreme weather**
- 8 Sea level rise

Part III: Impacts on ecosystems and society

- 9 Managing risks of extreme weather**
- 10 Mortality risk from extreme heat and cold
- 11 Climate change and US agriculture**
- 12 Climate change and global greening
- 13 Climate change and economic growth**
- 14 Estimates of the Social Cost of Carbon
- 15 US vehicle-based CO2 emissions and the global climate

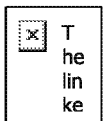
Steve: can you draft 1 & 3?

Judy: hoping you can do 8, 10 and 14 (I have info on 14 as well.)

John I think you have something on 15.

Cheers,  
Ross

Judith Curry, President  
CFAN - Climate Forecast Applications  
Network  
Reno, NV USA  
[curry.judith@cfanclimate.com](mailto:curry.judith@cfanclimate.com) |  
+1.404.803.2012  
<http://www.cfanclimate.net>





## Empirical methods [RM]

Equilibrium Climate Sensitivity (ECS) is defined as the expected amount of warming averaged over the Earth's surface in response to a doubling of CO<sub>2</sub>, after all climate systems have had time to adjust. Some systems, like temperatures in the troposphere, adjust very rapidly. Others may take decades or even centuries, such as the deep ocean and the cryosphere. A related metric which is sometimes more helpful on shorter time scales is the Transient Climate Response (TCR) defined as the amount of warming after 70 years in which atmospheric CO<sub>2</sub> goes up by one percent annually.

In large-scale General Circulation Models (aka climate models) ECS is not imposed as a direct parameter, instead it emerges from the behaviour of the underlying components of the model. These, however, are under the control of the modeler, so ultimately a model's ECS can be said to be built into it. Direct warming from CO<sub>2</sub> doubling is only about 1°C; the rest (to the extent more happens) arises due to climate feedbacks which are inherently more difficult to predict and model.

In 1979 the Charney (1979) Report for the US National Academy of Sciences proposed that the most likely value for ECS was 3.0°C plus or minus 1.5°C. Hence the best estimate was a likely tripling of the CO<sub>2</sub> effect through feedbacks. With only minor variations this range was adopted and reaffirmed by the IPCC until the most recent AR6. The range has been obtained primarily by examining the behaviour of climate models, but since key components of models are under the control of modelers this is not determinative of the actual climate's sensitivity. For example, Mauritsen and Roeckner (2020) confess regarding their Max Planck Institute model, "We have documented how we tuned the MPI-ESM1.2 global climate model to match the instrumental record of warming; an endeavor which has clearly been successful. Due to the historical order of events, the choice was to do this practically by *targeting an ECS of about 3 K using cloud feedbacks*, [emphasis added] as opposed to tuning the aerosol forcing." In other words, without appealing to fundamental physics the modelers chose an ECS of 3 K then tuned the cloud feedbacks to match their intended result.

A significant amount of effort has gone into estimating ECS empirically. There are several challenges to this work.

- First, it requires good data but observations of some key climatic systems, especially the oceans, are available in only very limited amounts.
- Second, identifying the effect of CO<sub>2</sub> requires simultaneously identifying the effect of aerosols. Climate models exhibit warming in response to GHGs but cooling in response to aerosols (Schwartz et al. 2007). Observed 20<sup>th</sup> century warming can be shown to be consistent either with low ECS and low aerosol cooling or high ECS and high aerosol cooling. Since fossil fuel use adds both GHGs and aerosols to the atmosphere, both effects need to be estimated to isolate the warming effect of CO<sub>2</sub>. Over time the IPCC's estimate of the cooling effect of aerosols has declined (Lewis 2022).
- Third, the simple empirical model typically used for the estimation, called an Energy Balance Model, requires estimating a feedback parameter which appears in the denominator of the equation for ECS. A small amount of uncertainty about the number in the denominator of a fraction can lead to very large uncertainties in the magnitude of the fraction itself. Roe and Baker (2007) pointed out that uncertainties in climate feedbacks are "highly amplified" in the resulting ECS.

Since 2012 many studies have appeared in the literature tackling these various uncertainties. A recurring theme is that ECS estimates based on historical data turn out to be smaller than ECS estimates inferred from climate models (Sherwood and Forest 2024). An early estimate (Stern and Kaufmann 2000) was 1.6°C, though this predated development of the Energy Balance Model method. Figure 1.6.1 shows the point or best estimates from 17 subsequent studies all appearing in the peer-reviewed literature after the TSD. The Charney range is shown for contrast. The average ECS estimate in the post-2012 sample is 1.8°C. The highest estimate, from Sherwood et al. 2020, is shown in red: it is the one that was used by the IPCC for the AR6 (Forster et al. 2021). The one adjacent to it, Lewis (2022), shows the result of, among other things, using the same method but applying more updated aerosol forcing data in the AR6 as well as some other recent updates to the source data. These updates dropped the ECS best estimate back down closer to the usual empirical range. The IPCC, following Sherwood et al. (2020) had estimated only a 5 percent probability that ECS was below 2.3°C was only 5 percent, whereas Lewis (2022) estimated it was over 50 percent.

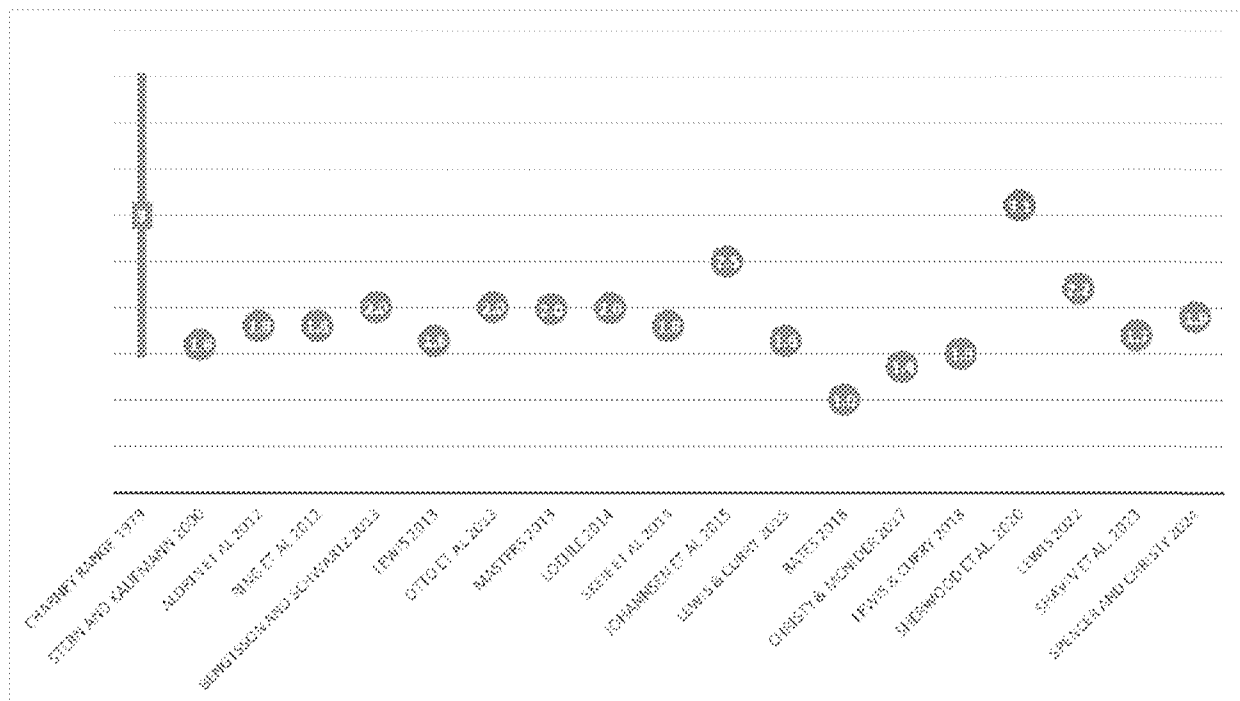


Figure 1.6.1: Empirical best estimates of ECS

A recent argument, one which the IPCC emphasized, that empirical ECS estimates might understate the future warming response to GHGs is based on a so-called “pattern effect” (Forster et al 2021). The tropical Pacific is believed to be highly influential on the overall efficiency with which the Earth’s climate radiates heat to space, but heat in some parts is more efficiently removed than from others. If in a warming climate there is a weakening of the west-to-east temperature gradient in the tropical Pacific the result would be a concentration of warming in a region where heat is less efficiently removed, raising the ECS of the Earth’s climate system. Most climate models simulate that rising GHGs will weaken the east-west temperature gradient, which led the IPCC in the AR6 to conclude that empirical ECS estimates understated what would be the *future* observed ECS value.

However Seager et al. (2019) pointed out that, contrary to models, the east-west temperature gradient has been strengthening rather than weakening over time. They further argued that the mechanism predicting otherwise in climate models was based on a faulty characterization of oceanic dynamics and there is no reason to expect the gradient to weaken. A similar argument was recently made by Lee et al. (2024), who concluded that “the trajectory of the observed trend reflects the response to increasing GHG loading in the atmosphere”, in other words GHG warming should lead to a future strengthening rather than a weakening of the temperature gradient. This implies, if anything, that future ECS in a warming climate will be lower than at present.

In summary, while the ECS range in climate models is very wide, historically climate models have embedded processes and assumptions that about secondary feedbacks that approximately triple the warming from CO<sub>2</sub>. Empirical estimates since the TSD however imply the climate is much less sensitive to CO<sub>2</sub> than this, with the estimates centered at or below 2°C. As discussed in Section 1.4.2 this is supported by studies which show climate models on average estimate too much warming at the surface and in the troposphere compared to observations over the past 50 years, and low-ECS models do better than high-ECS ones. Also this aligns with evidence from consistent fingerprinting (Section 1.5.1) that model responses to GHGs need to be scaled down quite a bit to align with observed trends. As will be discussed in Section 3.6, ECS values in the range of 2.0°C imply very low Social Cost of Carbon values.

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**From:** Judith Curry <curry.judith@gmail.com>  
**Sent:** Friday, April 25, 2025 4:44 PM  
**To:** John Christy  
**Cc:** Travis Fisher; Ross McKittrick; Roy Spencer; Steve Koonin  
**Subject:** Re: Apr 20 update  
**Attachments:** climate sensitivity JC text.docx

I'm out of the loop on the climate sensitivity chapter, but i have a lot of material on this which may be useful (attached)

On Fri, Apr 25, 2025 at 9:16 AM John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)> wrote:  
Ross

I believe you put together section 4 Climate. Sensitivity? I think we should take advantage of the IPCC AR6 Fig 3.8 (sent earlier) and insert it somewhere in this section. I think that HadGM is really a hoot as it had the strongest aerosol cooling and almost the hottest GHG warming, but, magically, ended up "just right". Anyway, something like this.

The uncertainty in modeled responses to specified aerosol and GHG forcings is indicated in Fig. 3.8 IPCC AR6 in which the historical temperature response from 1850-1900 to 2010-2019 is generated. The models' temperature responses to aerosol forcing varies from -1.0 to +0.1 °C (a range of 100% from the mean) and to GHG forcing of +1.0 to +2.2 °C (a range of 37% from the mean) as each model attempts to reach the pre-assigned target represented as the sum of the responses which is +1.0 °C. This wide range of responses to specified forcing given by the AR6 models (only 13 were used in Fig. 3.8) indicates physical processes within the models are based on very different formulations (parameterizations) which are thus of questionable physical meaning.

John C.

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Thanks Travis. I did not know things could move that quickly in the government.

John C.

John Christy  
Director, Earth System Science Center  
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[climateman60@gmail.com](mailto:climateman60@gmail.com)

On Apr 24, 2025, at 5:04 PM, Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:

Great news!

The Secretary just told me our new deadline is May 28th. I feel pretty strongly that this is a firm and final deadline, but it also feels like the best case scenario because we have renewed buy-in that EPA will wait for this work and include it in its rulemaking.

Please let me know how I can support your work. I've been intentionally hands-off so far, but I want you to feel free to assign research, drafting, or editing duties to me as needed.

Ross suggested we increase our coordination with EPA, particularly the legal team drafting the rulemaking. If you want to be included in those conversations, please let me know. But I'm also happy to handle the legal and policy issues if you'd rather not be involved in that nexus. The goal would be to make sure policymakers get your input on all the scientific questions they feel are relevant.

As you all get onboarded in various ways, please connect with me (ideally by phone) if you have any questions or if something about the offer or paperwork doesn't seem quite right. I'll work with the folks at DOE to make sure everything turns out the way you want.

Finally, the Secretary wanted me to send his thanks and appreciation for taking on this work. Thank you!

Best,  
Travis

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Hi all,

I've been waiting to chime in because I was hoping for more certainty by now, but the only thing I have to add is that Ross has won his fight with the White House about joining via contract (even though Ross is an evil foreigner from a strange place where people are conspicuously nice). It took a call from the Secretary, but we prevailed. (Ross, you'll be hearing more very soon.)

I can also confirm all the other information that was shared so far by Ross and John. The Secretary wants a thorough report that you all are proud of. If the EPA declines to use it, or demands an April 30 deadline, so be it, but the Secretary will move forward with the full report in any case.

The remaining variable (for me, anyway) is what to offer EPA if they demand a document before you all are comfortable putting your names on it. My preference is to supply them with something, even if it's in rough shape and unfit for attribution. Please think about what you all might want to do in that case because I think it's still a strong possibility. The main argument against supplying something in that case is that it would essentially be an early draft of the report Secretary Wright wants, so think about ways to differentiate the documents, etc.

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Part II: Climate response to anthropogenic influence

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Judy: hoping you can do 8, 10 and 14 (I have info on 14 as well.)

John I think you have something on 15.

Cheers,  
Ross



Judith Curry, President

CFAN - Climate Forecast Applications Network

Reno, NV USA

[curry.judith@cfanclimate.com](mailto:curry.judith@cfanclimate.com) | +1.404.803.2012

<http://www.cfanclimate.net>

## 7.1 Climate Sensitivity to CO<sub>2</sub> Emissions

Atmospheric CO<sub>2</sub> concentration has increased from its pre-industrial level of 280 parts per million (ppm) to around 412 ppm in 2021.<sup>26</sup> Human-caused warming depends not only on increasing greenhouse gases, but also on how sensitive the climate is to this increase.

Climate sensitivity is defined as the global surface warming that occurs when the concentration of CO<sub>2</sub> in the atmosphere is doubled, relative to pre-industrial levels.<sup>27</sup> The magnitude of the sensitivity of Earth's climate to increasing concentrations of CO<sub>2</sub> is at the heart of the scientific debate on anthropogenic climate change, and also the public debate on the appropriate policy response to increasing CO<sub>2</sub> in the atmosphere.

The magnitude of the climate sensitivity to a doubling of CO<sub>2</sub> concentration is associated with substantial uncertainties, which are highly consequential for policy making. If climate sensitivity to CO<sub>2</sub> concentration is low, then the impacts of increased emissions are expected to be relatively benign, and the benefits of emissions reductions much reduced. If the sensitivity is high, then even moderate increases of CO<sub>2</sub> could produce significant impacts. Climate sensitivity and estimates of its uncertainty are key inputs into the economic models that drive cost-benefit analyses and estimates of the social cost of carbon.

Since the 1979 Charney Report,<sup>28</sup> estimates in international assessment reports have put equilibrium climate sensitivity (ECS) between 1.5 and 4.5°C of warming for a doubling of CO<sub>2</sub> relative to pre-industrial levels. The ECS range between 1.5 and 4.5°C is characterized by the IPCC AR5 as the *likely* range (66 percent probability); the AR5 stated that ECS is *extremely unlikely* (95 percent probability) to be below 1.0°C and *very unlikely* (90 percent probability) to exceed 6°C.<sup>29</sup>

This range has remained stubbornly wide, despite many individual studies claiming to narrow it. Most recently, the IPCC AR6 narrowed the *likely* range of ECS to 2.5–4.0°C and the *very likely* range to be between 2.0 and 5.0°C.<sup>30</sup> This narrowing of the range on the low end is disputed.<sup>31</sup>

Understanding of the uncertainties is illuminated by examining the different methods of estimating climate sensitivity and the confounding effects of feedback processes.

### 7.1.1 Different Ways of Estimating Sensitivity

“[W]e were under the necessity of collecting together a variety of facts, and of entering into long trains of reasoning.” (Geologist Charles Lyell)<sup>32</sup>

Climate scientists use multiple lines of evidence to assess climate sensitivity:

- Process understanding
- Climate model simulations
- Historical observations

- Paleoclimatic observations

By itself, the equilibrium warming effect of a doubling of atmospheric CO<sub>2</sub> is slightly more than 1°C.<sup>33</sup> The large values of ECS arise from positive feedbacks that amplify the warming effect of CO<sub>2</sub>. Water vapor feedback is positive: a warmer atmosphere may have more water vapor, which itself is a powerful greenhouse gas. Water vapor feedback is partially canceled by the fact that atmospheric temperature decreases more slowly with height above the Earth's surface when atmospheric water vapor increases. Warmer temperatures also result in less snow and sea ice cover, allowing the Earth to absorb more of the sun's radiation. Some simple estimates of these three feedbacks increase the ECS to around 2°C.<sup>34</sup>

Higher values of ECS arise primarily from positive cloud feedbacks. The magnitude, and even the sign, of cloud feedbacks is the greatest source of uncertainty. Elements of cloud feedback include changes in the latitudinal distribution of clouds, changes in the distribution of cloud height (changes in low versus high clouds), changes to the phase of clouds (ice versus liquid), changes in cloud particle size (associated with changes in concentration and/or composition of aerosol particles), changes in the precipitation efficiency of clouds, and even changes in how clouds are distributed over the daily solar cycle.<sup>35</sup> It is difficult for climate models to simulate any of these cloud processes correctly owing to their small scale, let alone predict how they will change in the future. Further, cloud processes modulate the magnitudes of the water vapor, lapse rate, and the surface albedo feedbacks.<sup>36</sup>

ECS can be determined from climate model simulations by doubling the concentration of CO<sub>2</sub>, allowing several centuries for the warming to equilibrate. To avoid the necessity of long simulations, effective climate sensitivity is commonly evaluated from a 150-year simulation in response to a sudden quadrupling of CO<sub>2</sub>. The spread of ECS values from the CMIP5 climate models (used in the AR5) was 2.0–4.7°C; the spread has increased for the CMIP6 models (used in the AR6) to between 1.8 and 5.5°C.<sup>37,38</sup> Far from the science being settled in relation to the response of the climate system to increasing greenhouse gas concentrations, insofar as it is represented by climate models, uncertainties appear to be growing. The main cause of the overall upward shift in ECS in CMIP6 relative to CMIP5 is a larger positive cloud feedback, driven by changes to the cloud parameterizations in many CMIP6 models.<sup>39</sup>

Climate sensitivity represents an emergent property of climate models— that is, it is not directly parameterized or tuned. However, collections of parameterizations are often chosen to produce an expected value of climate sensitivity, particularly with regards to sub-grid-scale cloud processes. Otherwise plausible models and parameter selections have been discarded because of perceived conflict with this warming rate, or aversion to a model's climate sensitivity being outside an accepted range.

The IPCC AR4 (2007) relied almost exclusively on climate models in its

assessment of ECS. The IPCC AR5 (2013) relied on both climate model determinations and determinations from the historical record, noting substantial disagreements between these two methods. The IPCC AR6 (2021) did not rely on climate model simulations in their assessment of climate sensitivity, relying on the other three methods in its assessment.

Climate sensitivity is also estimated from instrumental records of surface temperatures and ocean heat content, combined with estimates of how climate forcings (e.g., greenhouse gases, solar, volcanoes, aerosols) have changed in the past.<sup>40</sup> Using this information, an energy budget method is used to deduce the ECS. The greatest source of uncertainty in the energy budget method using historical data is uncertainty in the amount and composition of aerosol particles and their interactions with cloud radiative properties (the so-called aerosol indirect effect). Assumptions are also needed about ocean heat storage.

Paleoclimate proxies are used to evaluate the sensitivity of past climates, by comparing paleoclimate changes in the Earth's temperatures to estimates of changes in forcings. The two most informative periods are the last glacial maximum (around 20,000 years ago), which was about 3–7°C colder than today, and a mid-Pliocene period (roughly three million years ago), which was 1–3°C warmer than today.<sup>41</sup> The limits on cooling during the last glacial maximum give the best single evidence that high values of climate sensitivity are unlikely. However, paleoclimate estimates are associated with very large uncertainties in the estimated temperatures and forcings. Further, estimates of climate sensitivity based on past climate states may not be representative of the current state of the climate system.

Based on a recent review article by Sherwood et al., the IPCC AR6 integrated all of the different streams of inputs using a Bayesian analysis method.<sup>42</sup> The IPCC AR6 narrowed the likely range of ECS to 2.5–4.0°C.<sup>43</sup> Subsequent to publication of the AR6, independent climate scientist Nic Lewis (see also Section 2.4.1) published in the journal *Climate Dynamics* an extensive critique of the methodology used in the Sherwood et al. paper to determine the ECS.<sup>44</sup> Key concerns raised by Lewis include errors, outdated input values, and objective versus subjective Bayesian priors in the analysis. Lewis' analysis found that climate sensitivity is estimated to be much lower and better constrained than in the Sherwood et al. analysis – median 2.16°C (1.75–2.7°C in the 17–83 percent *likely* range), and 1.55–3.2°C in the 5–95 percent *very likely* range. This analysis implies that climate sensitivity is considerably more likely to be below 2°C than above 2.5°C.<sup>45</sup>

### **7.12 Transient Climate Response**

The Transient Climate Response (TCR) is of greater utility in providing an observational constraint on climate sensitivity. TCR is the amount of warming that would occur at the time when CO<sub>2</sub> doubles, having increased gradually by 1 percent each year over a period of 70 years. Relative to the ECS, observationally-determined values of TCR avoid the problems of uncertainties in ocean heat

uptake and the fuzzy boundary in defining equilibrium arising from a range of timescales for the longer-term feedback processes (e.g., ice sheets). TCR is more generally related to peak warming and better constrained by historical warming, than ECS. The IPCC AR6 judged the *very likely* range of TCR to be 1.2–2.4°C.<sup>47</sup> In contrast to ECS, the upper bound of the TCR is more tightly constrained.

A related but more flexible parameter is the Transient Response to cumulative carbon Emissions, or TCRE, which relates global temperature change to the cumulative emissions. TCRE is based upon a linear relationship between global average temperature and cumulative emissions, which holds for cumulative emissions of up to 2 teratons of carbon. For a given value of TCRE, we can calculate the amount of warming expected over a future period in response to scenarios of cumulative carbon emission. The IPCC AR6 provides a *very likely* range for TCRE of 1.0–2.3°C, with a median value of 1.6°C.<sup>48</sup>











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**Sent:** 4/25/2025 4:18:20 PM  
**To:** Travis Fisher [travis.scott.fisher@gmail.com]  
**CC:** Ross McKittrick [ross.mckittrick@gmail.com]; Roy Spencer [roywspencer@hotmail.com]; Steve Koonin [steven.koonin@gmail.com]; Judith Curry [curry.judith@gmail.com]  
**Subject:** Re: Apr 20 update

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Great news!

The Secretary just told me our new deadline is May 28th. I feel pretty strongly that this is a firm and final deadline, but it also feels like the best case scenario because we have renewed buy-in that EPA will wait for this work and include it in its rulemaking.

Please let me know how I can support your work. I've been intentionally hands-off so far, but I want you to feel free to assign research, drafting, or editing duties to me as needed.

Ross suggested we increase our coordination with EPA, particularly the legal team drafting the rulemaking. If you want to be included in those conversations, please let me know. But I'm also happy to handle the legal and policy issues if you'd rather not be involved in that nexus. The goal would be to make sure policymakers get your input on all the scientific questions they feel are relevant.

As you all get onboarded in various ways, please connect with me (ideally by phone) if you have any questions or if something about the offer or paperwork doesn't seem quite right. I'll work with the folks at DOE to make sure everything turns out the way you want.

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Thanks again for your hard work under an impossible deadline. I'll update you all as soon as we get a new (interim/rushed) deadline from EPA. It's my understanding that the Secretary initially asked for May 15, but it's possible he will ask for even more time after hearing directly from Ross about how helpful it would be to get another full month (or more). Wright and Zeldin are traveling together today, so we should have an answer soon.

Best,  
Travis

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I see. CO2 is about 79% of the total human forcing -(which includes aerosol cooling - a real wild card). Other GHGs are about 60% of the total forcing, so  $60/79 \sim 3/4$ . Together they are 139% of total forcing.

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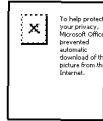
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<Ch0&1.[SEKApr22][RSApr23][RMApr23].docx>

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Steve's chart suggests 75%... kinda surprised. Of course, these estimates all have associated uncertainties.  
-Roy

Sent from my Verizon, Samsung Galaxy smartphone

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**From:** Steven Koonin <steven.koonin@gmail.com>  
**Sent:** Wednesday, April 23, 2025 4:02 PM  
**To:** John Christy  
**Cc:** Ross McKittrick; Judith Curry; Roy Spencer; Travis Fisher  
**Subject:** Re: Apr 20 update

You can read off the official numbers from the second IPCC figure I included. I'd do that myself , but don't have access to it at the moment.  
Steven E. Koonin

On Apr 23, 2025, at 12:37, John Christy <climateman60@gmail.com> wrote:

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**Sent:** Wednesday, April 23, 2025 3:41 PM  
**To:** judith curry  
**Cc:** John Christy; Roy Spencer; Steve Koonin; Travis Fisher  
**Subject:** Re: Apr 20 update

Good point about clouds. There has been a few studies pointing to 21st century downward trends in cloud cover. I have:

Dubal and Vahrenholt <https://www.mdpi.com/2073-4433/12/10/1297>

Loeb et al. <https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2021GL093047>

Loeb et al 2204 <https://link.springer.com/article/10.1007/s10712-024-09838-8>

On Wed, Apr 23, 2025 at 3:19 PM judith curry <curry.judith@gmail.com> wrote:

I would add the Connolly ref. The other issue is that since 2015 the radiative imbalance has been solar caused by reduced cloud cover. There are numerous papers on this including one by Jim Hansen. I can dig up refs once I return from travel

Sent from my iPhone

On Apr 23, 2025, at 1:11 PM, Ross McKittrick <ross.mckitrick@gmail.com> wrote:

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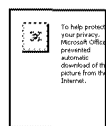
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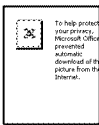
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**From:** Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>

**Sent:** Sunday, April 20, 2025 8:09 PM

**To:** Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>; John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>; Roy W. Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>; Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>; Judith Curry <[curry.judith@gmail.com](mailto:curry.judith@gmail.com)>

**Subject:** Apr 20 update

I've created a new dropbox folder called April 20 version which contains the revised outline, the associated chapters and the reference list for all my sections. I took the documents done prior to this point and renumbered the files and sections accordingly.

The new outline is (bold denotes draft posted)

Part I: Human influence on the climate

- 1 Components of anthropogenic radiative forcing and their history to date
- 2 The carbon cycle and future emission scenarios**
- 3 Aerosols and the uncertainties associated with them

Part II: Climate response to anthropogenic influence

- 4 Measuring climate sensitivity to CO2 doubling**
- 5 Models versus observations in recent past**
- 6 Uncertainties in analysis of attribution**
- 7 Evidence on trends and attributable changes in extreme weather**
- 8 Sea level rise

Part III: Impacts on ecosystems and society

- 9 Managing risks of extreme weather**
- 10 Mortality risk from extreme heat and cold
- 11 Climate change and US agriculture**
- 12 Climate change and global greening
- 13 Climate change and economic growth**
- 14 Estimates of the Social Cost of Carbon
- 15 US vehicle-based CO2 emissions and the global climate

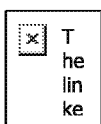
Steve: can you draft 1 & 3?

Judy: hoping you can do 8, 10 and 14 (I have info on 14 as well.)

John I think you have something on 15.

Cheers,  
Ross

Judith Curry, President  
CFAN - Climate Forecast Applications  
Network  
Reno, NV USA  
[curry.judith@cfanclimate.com](mailto:curry.judith@cfanclimate.com) |  
+1.404.803.2012





## **0. Introduction**

This document provides technical support for the endangerment and cause or contribute analyses concerning greenhouse gas (GHG) emissions under section 202(a) of the Clean Air Act. It does not convey any judgment or conclusion regarding the question of whether GHGs may be reasonably anticipated to endanger public health or welfare, as this decision is ultimately left to the judgment of the Administrator.

Assessing the dangers created by GHG emissions from US road vehicles involves a long chain of inference.

1. How will emission of GHGs (principally CO<sub>2</sub>) influence the future climate?
2. How will the climate change under those growing influences?
3. How will those changes affect ecosystems and society?

The current certainties and uncertainties in each of these questions are considered in the following three chapters. The presentation is based on official UN and US government assessment reports, the peer reviewed literature and, in some cases, straightforward analyses of official data. Attribution of climate change to anthropogenic influences is discussed along with uncertainties regarding natural sources of climate change, which remain poorly understood. In addition to climate changes due to changes in the global energy balance between absorbed sunlight and emitted heat radiation at the top of the atmosphere, climate can also change from unforced, chaotic variations within the climate system itself, such as atmospheric circulation-induced changes in cloud cover or changes in the rate of overturning of the global oceans. This “known unknown” should be kept in mind in discussions of anthropogenic climate change.

## **1. Human influences on the climate**

### **1.1. Radiative forcing**

*A changing climate has been the norm throughout the Earth’s 4.6-billion-year history. The Earth’s temperature and weather patterns change naturally over timescales ranging from decades to millions of years. Natural variations in the surface climate originate in two ways. Internal climate fluctuations associated with circulations in the atmosphere and ocean produce exchanges of energy, water, and carbon between the atmosphere, oceans, land, and ice. External influences on the climate system include variations in the energy received from the sun and the effects of volcanic eruptions. Human activities influence climate through changing land use and land cover. Humans are also changing atmospheric composition by increasing the emissions of CO<sub>2</sub> and other greenhouse gases and by altering the concentrations of aerosol particles in the atmosphere.*

The earth is warmed by the sunlight it absorbs and cooled by the radiative heat it emits to outer space. Averaged over Earth, each of these processes involve power flows of about 240 W/m<sup>2</sup>.

When they are in balance, there are no net external causes of warming or cooling. Human (and some natural) influences on the climate alter this balance and so cause the climate to change.

Influences on the climate are quantified by “radiative forcing”, the extent to which they disturb the warming/cooling balance; a positive forcing warms while a negative forcing cools. The IPCC’s estimated history of major components of radiative forcing since 1750 is shown in the following two figures from IPCC AR6:

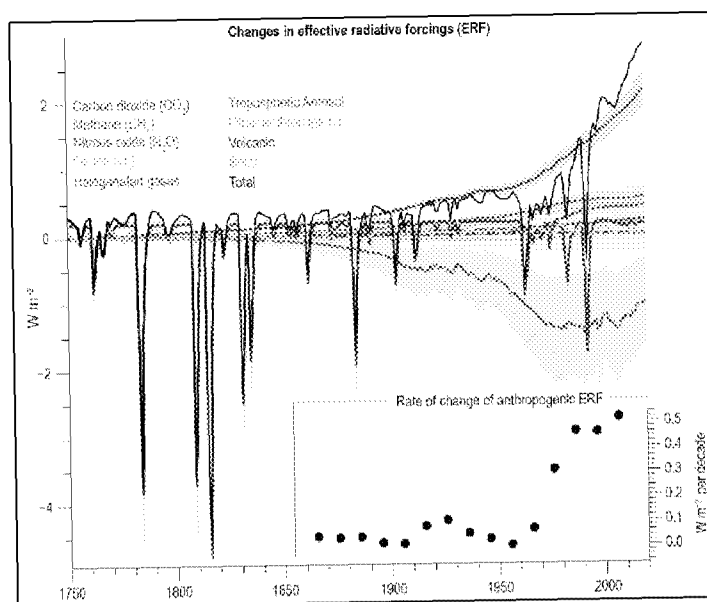


Figure 1.1.1

<https://www.ipcc.ch/report/ar6/wg1/figures/chapter-2/figure-2-10/>

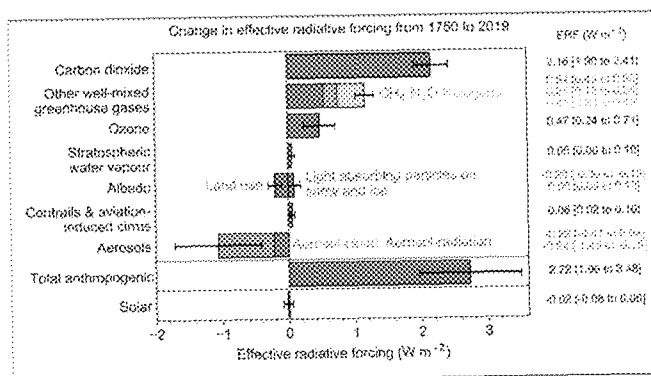


Figure 1.1.2

<https://www.ipcc.ch/report/ar6/wg1/figures/chapter-7/figure-7-6/>

These graphs show that the total radiative forcing is comprised of natural and anthropogenic components. The natural component is largely volcanic aerosols, which exert an episodic cooling effect; the IPCC deems solar variations to have had negligible influence. The anthropogenic

component was negligible before about 1900 and has increased steadily since, rising to almost 3 W/m<sup>2</sup> today. However, this is still only about 1 percent of the unperturbed radiation flows, making it a challenge to isolate the effects of anthropogenic forcing since state-of-the-art satellite estimates of global radiative energy flows are only accurate to a few Watts per sq. meter. Natural sources of global energy imbalance other than volcanoes are not included in these graphs because they remain largely unknown.

Carbon dioxide is the largest human influence on the climate and the one most relevant to the effects of motor vehicles; its emissions are accumulating in the atmosphere, as described in the following section. It exerts a warming influence by decreasing the cooling power of the atmosphere. Other greenhouse gases (methane, nitrous oxide, halogens, and ozone), which act similarly, currently add another 75% to CO<sub>2</sub>'s warming. Aerosols exert a cooling effect, although with large uncertainties in the way they catalyze the formation of reflective clouds. As a result, understanding of the causes of recent warming requires not just identifying the warming effects of CO<sub>2</sub>, but also the more uncertain cooling effects of sulfate aerosols.

### **1.2. Future radiative forcing**

Carbon dioxide's warming influence depends upon how much "extra" CO<sub>2</sub> accumulates in the atmosphere- i.e., it's concentration. The CO<sub>2</sub> level as recorded at the Mauna Loa observatory in Hawaii is generally used as the representative global average concentration. The data are available online at <https://gml.noaa.gov/ccgg/trends/index.html>. The concentration was about 316 ppm at the start of the record in 1959 and is now about 425 ppm, a 34 percent increase.

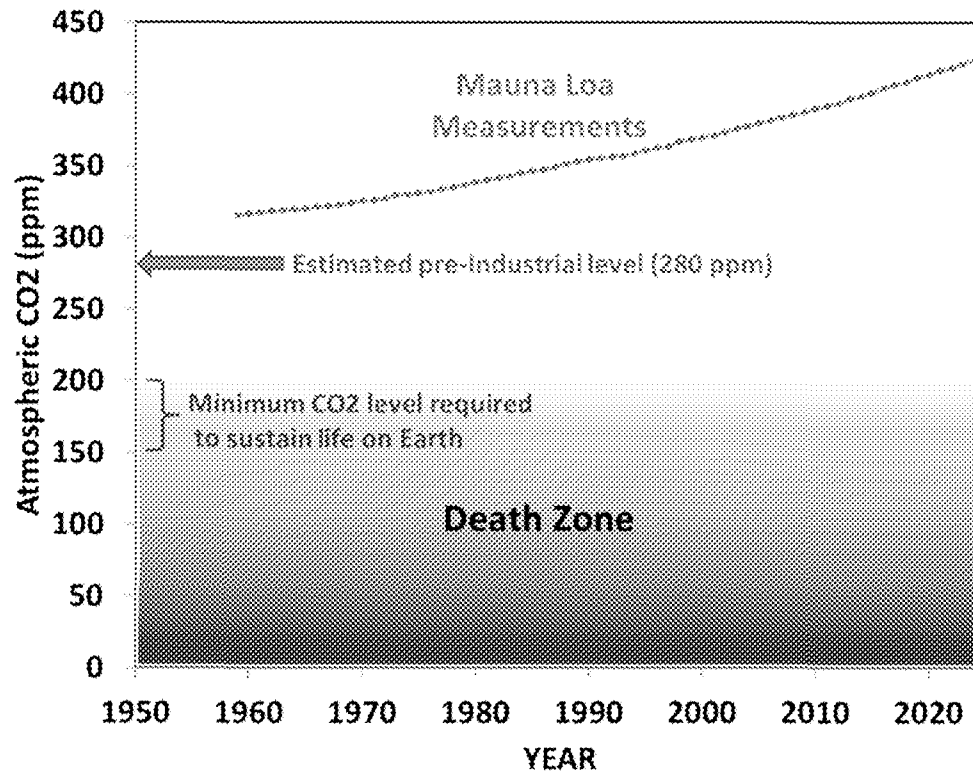


Fig. 1.2.1 Yearly average atmospheric CO<sub>2</sub> concentrations (1959-2024) measured at Mauna Loa, HI (green) compared to the estimated pre-Industrial CO<sub>2</sub> concentration of 280 ppm, and the estimated minimum levels required to sustain life on Earth (150 to 200 ppm).

The annual increase in concentration is only about half of the CO<sub>2</sub> emitted because land and ocean processes absorb “excess” CO<sub>2</sub> at a rate approximately 50% of human emissions. Thus, future concentrations, and hence future human influences on the climate, depend upon two components: (1) future rates of global human CO<sub>2</sub> emissions, and (2) how fast the land and ocean remove extra CO<sub>2</sub> from the atmosphere. We discuss each of these in turn.

### 1.2.1. Emissions scenarios

Assessing the future dangers of GHG emissions requires assumptions about what those emissions will be. Future emissions, and hence human influences on the climate, will depend upon future demographics, economic progress, regulation, and the energy and agricultural technologies in use. Various assumptions about each of those lead to projections of greenhouse gas emissions and concentrations, aerosol concentrations, and changes in land use, which ultimately can be combined into assumptions about anthropogenic radiative forcing.



Because of the great uncertainties about the decades to come, instead of making precise predictions of future concentrations, the IPCC has created various sets of scenarios meant to span a plausible range of possibilities for population, economy, technology, and so on. Recent versions of the scenarios are labeled by a number indicating the anthropogenic radiative forcing expected in 2100 under that scenario. Thus, a scenario labeled with a “6” corresponds to 6 W/m<sup>2</sup> of human-induced radiative forcing (warming) at the end of the century. (Recall current anthropogenic radiative forcing is about 2.7 W/m<sup>2</sup>.)

Although the IPCC does not put its emission scenarios forward as forecasts they are often treated as such. Comparisons of past scenario groups against observations shows a tendency for IPCC emission projections to overstate actual subsequent emissions. For the IPCC 3<sup>rd</sup> and Fourth Assessment Reports a set of emission projections from the *Special Report on Emission Scenarios* were used, and hence were referred to as the SREP scenarios. McKittrick et al. (2012) showed that, when converted to per capita terms, the SREP scenario distribution was skewed upwards and incompatible with observed trends. McKittrick and Wood (2013) further showed that global energy market dynamics constrained global per capita CO<sub>2</sub> emissions to an extent not reflected in IPCC scenarios. The bias of the SRES scenarios was confirmed by the later analysis in Hausfather et al. (2019) who showed that observed atmospheric CO<sub>2</sub> levels tracked the low end of the SRES range.

For the Fifth Assessment Report the IPCC developed a new set of scenarios called the Representative Concentration Pathways (RCP). These were identified by a number representing the increase in forcing and were thus called RCP2.6, RCP4.5, RCP6.0 and RCP8.5. RCP2.6 (implying a gain of 2.6 Watts per square meter) projects a GHG concentration pathway which implies warming remains well below 2°C. At the other end of the scale RCP8.5 is an extreme outcome implying nearly 5°C warming just in this century.

In both the academic literature and popular media RCP8.5 came to be referred to as the no-policy baseline, or “business-as-usual” scenario. It was used in this way to generate the reference outcome supposedly representing the 21<sup>st</sup> century world in the absence of emission reduction policies. But RCP8.5 was intended as a low-probability high emissions scenario and its usage as a business-as-usual baseline has been criticized as grossly misleading. Hausfather and Peters (2020) writing in a commentary in *Nature* magazine, pointed out that RCP8.5 was developed as an extreme worst-case, and its misuse as a “business as usual” baseline has resulted in a large number of misleading studies and media reporting:

RCP8.5 was intended to explore an unlikely high-risk future. But it has been widely used by some experts, policymakers and the media as something else entirely: as a likely ‘business as usual’ outcome. A sizeable portion of the literature on climate impacts refers to RCP8.5 as business as usual, implying that it is probable in the absence of stringent

climate mitigation. The media then often amplifies this message, sometimes without communicating the nuances. This results in further confusion regarding probable emissions outcomes, because many climate researchers are not familiar with the details of these scenarios in the energy-modelling literature.

(Hausfather and Peters 2020)

The implausibility of the RCP8.5 scenario was examined by Burgess et al. (2021). They noted that RCP8.5 has already diverged from observed energy use trends, and the near future trends diverge sharply from those of the International Energy Agency (IEA) which provides market-based projections of energy use for coming decades. IEA trends are based on plausible extrapolations of current economic and demographic trends, and the results run below the entire envelope of RCP projections, implying not only that RCP8.5 is dubious, but even lower emission scenarios are looking unlikely. Burgess et al. comment (p. 8):

Beyond 2040, if the trends anticipated by energy agency forecasts continue, carbon intensity will continue diverging from AR5 and SSP baselines—especially from higher-emission scenarios such as RCP8.5, due to the assumptions about fossil-fuel expansion in these scenarios that are increasingly implausible.

Widespread use of RCP8.5 has caused a bias towards alarmism in the climate impacts literature. The extent of this problem was confirmed in a literature analysis by Pielke Jr. and Ritchie (2020). They found (p. 32) that between 2010 and 2020 some 16,800 scientific papers had been published using the RCP8.5 scenario, and (p. 16) that about 4,500 of the articles linked RCP8.5 with the concept of “business-as-usual”. They provided analyses of how RCP8.5 was misused not only by individual researchers, but by influential science agencies like the IPCC and the US National Climate Assessment (USNCA), which has directly led to misleading coverage in prominent media outlets. They provide the following example (p. 30):

The USNCA employed RCP8.5 as a baseline scenario, despite warning against such use, and compared it to RCP4.5 throughout its report to generate quantitative economic estimates of the benefits of mitigation. In a front-page story, the *New York Times* promoted the report’s misuse of RCP8.5 as a baseline scenario:

“A major scientific report issued by 13 federal agencies on Friday presents the starkest warnings to date of the consequences of climate change for the United States, predicting that if significant steps are not taken to rein in global warming, the damage will knock as much as 10 percent off the size of the American economy by century’s end.”

Pielke and Ritchie (2020) reported new studies using RCP8.5 were appearing in the literature at a rate of about 20 per day, with about two per day specifically linking RCP8.5 and “business as usual.” They conclude (p. 34) that the climate research community has spent a decade “committing scientific resources to science fiction” (emphasis added):

“Derived estimates from RCP8.5 as “business as usual” such as future climate impacts, the impacts avoided from mitigation and the cost effectiveness and benefits of mitigation have no real-world meaning... **The scientific literature has become imbalanced in an apocalyptic direction.**

(Pielke Jr. and Ritchie p. 34)

The IPCC later converted the RCP scenarios to the “Shared Socioeconomic Pathway” or SSP scenarios, but these have continued the pattern of bias shown with the RCP and SRES scenarios. Figure 1.4.3.2, generated using the Resources for the Future Global Energy Outlook tool (RFF 2025). The black line shows total global observed CO<sub>2</sub> emissions from the International Energy Agency (IEA). The solid green line is the emission trajectory developed by BP energy taking account of current emission control policies and global energy use outlooks. current policy proposals. It overlaps a solid black line which represents the emission projection from the IEA also taking account of energy use projections and current policies. The dashed lines show the range of IPCC SSP policies. As of 2023 global CO<sub>2</sub> emissions have been tracking well below the SSP scenarios especially the two highest ones (SSP5-8.5 and SSP3-7.0).

**Carbon dioxide emissions (Million metric tons), by Outlooks & Scenarios. Filtered by Region: World; Fuel: All; Outlook: 2023 Shell (Sky 2050).**

Source: RFF Global Energy Outlook at [www.rff.org/geo](http://www.rff.org/geo)

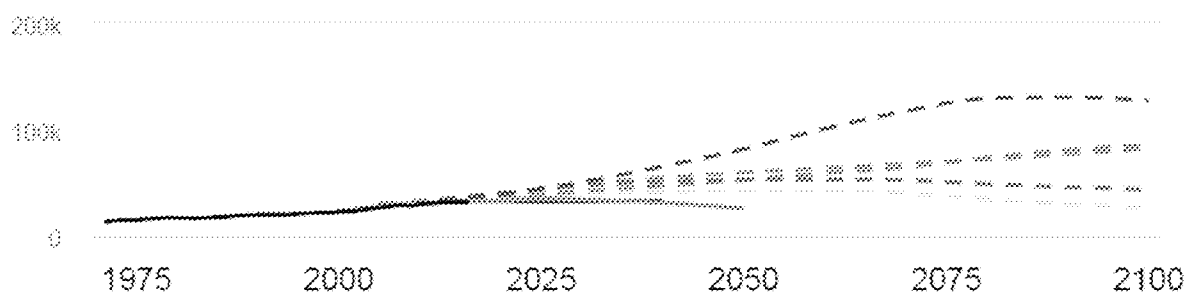


Figure 1.2.2. Observed and projected CO<sub>2</sub> emissions. Source: RFF (2025).

### 1.2.2. The carbon cycle relating emissions and concentrations

Global carbon cycle models relate concentrations to emissions using estimates of various land and ocean processes that remove CO<sub>2</sub> from, and emit CO<sub>2</sub> into, the atmosphere. Our understanding of these processes was reviewed by Crisp et al. (2021). The natural fluxes of CO<sub>2</sub> in and out of the Earth's surface are very large, many times anthropogenic emissions, but those CO<sub>2</sub> sources and sinks were assumed to be in approximate balance in pre-Industrial times, as evidenced by relatively constant levels of atmospheric CO<sub>2</sub> in centuries past derived from air bubbles in ice cores. This is one of several reasons why increasing atmospheric CO<sub>2</sub> levels are believed to be dominated by anthropogenic sources.

Specifically, fossil fuel burning (and to a lesser extent land use [biomass burning] and cement production) has led to steadily increasing CO<sub>2</sub> levels in the atmosphere, as shown in Fig. 1.2.1. CO<sub>2</sub> emissions from fossil fuel burning is a small fraction of the natural carbon cycle components. About 44,000 Gigatonnes of carbon-equivalent (GtC) are stored in the atmosphere and oceans, mostly in the form of CO<sub>2</sub>. (Ciais et al. 2013). Between 150 and 200 GtC are released naturally each year through oceanic outgassing and land-based processes like plant decay and animal respiration. A variable but roughly equivalent amount is absorbed each year by the land and oceans, with a small net loss from the atmosphere because the formation of deep ocean sediment sequesters some carbon permanently. Global fossil fuel consumption and cement manufacture released about 10.3 GtC in 2023, up from 6.2 GtC in 1990 (Ritchie et al. 2024). Of this, about half is naturally sequestered through plant growth and oceanic uptake while the remainder, about half, adds to the atmospheric stock (Ciais et al. 2013).

As noted, each year natural processes remove a net amount of CO<sub>2</sub> equivalent to about 50% of global emissions. Thus, anthropogenic CO<sub>2</sub> emissions average twice what is required to explain the atmospheric rise in CO<sub>2</sub> concentration. The near-constancy of that 50% fraction (the “airborne fraction”) also means that the more CO<sub>2</sub> humanity produces, the faster Nature removes it from the atmosphere. That 50% fraction changes somewhat from year to year due to natural carbon cycle imbalances from El Nino, La Nina, and varying weather patterns. There was also a substantial additional reduction in atmospheric CO<sub>2</sub> after the 1991 eruption of Mt. Pinatubo, a curious result that has yet to be explained (Angert et al., 2004).

The main processes which remove excess CO<sub>2</sub> from the atmosphere are increased production of land vegetation (especially at high latitudes), some increase in the sequestering of carbon

in soils, and uptake of CO<sub>2</sub> by the ocean due to the increasing partial pressure of atmospheric CO<sub>2</sub> over that of CO<sub>2</sub> dissolved in the ocean. All twenty land carbon cycle models tracked by the Global Carbon Project (Friedlingstein et al., 2024) show land processes have been removing excess CO<sub>2</sub> at an increasing rate since 1959. This is consistent with a “global greening” phenomenon observed by satellites since monitoring of global greenness began in the 1982. This greening has been traced to CO<sub>2</sub> fertilization and greater drought tolerance of plants exposed to elevated CO<sub>2</sub> levels. While there had been some uncertainty whether a greening trend continued beyond 2000, the most recent research (Chen et al., 2023) has shown continued greening, with even some slight acceleration since 2000. Global greening is discussed further in Section 3.1.

While land vegetation has been responding positively to more atmospheric CO<sub>2</sub>, uptake of extra CO<sub>2</sub> by ocean biological processes remains too uncertain to be reliably measured. Our current understanding of these and many more carbon cycle processes was reviewed by Crisp et al. (2021).

### **1.3. CO<sub>2</sub> as a “pollutant”**

Whether CO<sub>2</sub> falls in the legal category of pollutant is ultimately a legal question. But the answer should be informed by the scientific similarities and differences between CO<sub>2</sub> and other generally acknowledged pollutants.

CO<sub>2</sub> is fundamentally different from criterion air contaminants like SO<sub>2</sub> and NO<sub>x</sub> for two reasons. First, the damage from criterion air contaminants stems from their local ground-level concentration, since that is what affects human welfare. But local variations in CO<sub>2</sub> levels do not affect human health. Ambient outdoor air averages about 0.04% CO<sub>2</sub> although the level varies in response to nearby vegetation, traffic and other influences. Commercial greenhouses raise the CO<sub>2</sub> level to about 0.1% to boost plant growth. Humans exhale breath containing 4% CO<sub>2</sub> so the air inside cars and buildings can easily reach concentrations five times the ambient outdoor level, without health effects. The potential channel of influence is through variations in the global climate which operates through the global average atmospheric CO<sub>2</sub> concentration. (Another influence is the positive local effect on crop productivity which will be discussed in Section 3.2).

The second reason is that policy can only change the rate of emissions, not the concentration in the atmosphere. For criterion air contaminants the rate and concentration are closely connected because the lifetime is short and the concentration is small. When emissions are reduced the local pollution concentration drops rapidly, usually on a time scale of a few days. Not so with the global average CO<sub>2</sub> concentration since global carbon cycle is vast and slow. A change in local emissions today will only have a very small global effect, and only after a long time lag. After a pulse (release) of CO<sub>2</sub> emissions to the atmosphere only about 40 percent ( $\pm 15\%$ ) of the extra CO<sub>2</sub> will have been sequestered after twenty years. After a

thousand years about 75 percent ( $\pm 10\%$ ) will have been sequestered, and the remainder will gradually be removed over the ensuing tens of thousands of years (Ciais et al. 2013, pp. 472-473). Consequently US CO<sub>2</sub> emission reductions will take decades or centuries to lead to a reduction in the global CO<sub>2</sub> concentration.

To reduce the atmospheric stock of CO<sub>2</sub>, assuming the entire increase is anthropogenic, would require emissions to fall below the natural sequestration rate. Since that rate has been averaging about 50% of emissions, a reduction of global emissions by 50% would (at least temporarily) halt the rise in atmospheric CO<sub>2</sub>. The 1997 Kyoto Protocol proposed to cap industrial nations' CO<sub>2</sub> emissions at a modest five percent below 1990 levels by the year 2012. Even though this policy ended up too costly for most nations to implement, full compliance would not have substantially reduced atmospheric CO<sub>2</sub> levels. It would only have slightly slowed CO<sub>2</sub> growth, reaching the projected 2100 level in 2105 instead (Wigley 1998). Similarly, Lomborg (2016) used the widely-used MAGICC climate model and showed that full compliance with the Paris Accord would not stop warming, it would only prevent about 0.1C warming and delay hitting the baseline year 2100 temperature levels by about a decade.

Thus, in contrast with conventional air pollution control, local actions yield extremely small local effects, and only after a long time lag. The practice of referring to unilateral US reductions as “combatting climate change” or “taking action on climate” reflects a profound misunderstanding of the scale of the issue. The scale problem is compounded by recognizing that US motor vehicles account only for about 4 percent of global CO<sub>2</sub> emissions so even a fifty percent reduction in those emissions would have a vanishingly small effect on the global climate.

#### **1.4. Summary**

- The global climate is naturally variable. Anthropogenic CO<sub>2</sub> emissions add to that variability by changing the total radiative balance in the atmosphere.
- When the two components required to estimate future atmospheric CO<sub>2</sub> concentrations are combined (anthropogenic emissions estimates along with carbon cycle model estimates of atmospheric CO<sub>2</sub> removal), we get estimates of future CO<sub>2</sub> concentrations and hence the radiative forcings required by climate models to estimate future rates of warming.
- IPCC emission scenario envelopes have tended to exceed observed trends.
- The vast majority of academic climate “impacts” studies in recent years are based on the RCP8.5 scenario that is considered implausible, and its usage as a business-as-usual scenario is misleading.
- Despite ample evidence that scenario envelopes are exaggerated, and despite criticism of this practice in the peer-reviewed literature, the IPCC’s most recent scenario set called SSP carries on with this pattern.

- Unlike criterion air contaminants, local emissions and local levels of CO<sub>2</sub> have no human health implications. The only potential effects are CO<sub>2</sub> fertilization of plants (a benefit) and modifications of the global climate.
- The global carbon cycle heavily dampens the effect of changes in local (e.g. U.S.) CO<sub>2</sub> emissions. Even global-scale emission reductions will have only small effects, long in the future.

---

**From:** John Christy <climateman60@gmail.com>  
**Sent:** Wednesday, April 23, 2025 10:39 AM  
**To:** Judith Curry  
**Cc:** Roy Spencer; Steve Koonin; Ross McKittrick; Travis Fisher  
**Subject:** Re: Apr 20 update

Roy and Steve

I scanned the document in between meetings. Is there any information on the contribution of vehicle emissions relative to the overall emissions?

John C.

John Christy  
Director, Earth System Science Center  
Professor, Atmos and Earth Science  
Alabama State Climatologist  
The University of Alabama in Huntsville  
climateman60@gmail.com

On Apr 23, 2025, at 7:48 AM, Judith Curry <curry.judith@gmail.com> wrote:

Here's a paragraph from my book

A changing climate has been the norm throughout the Earth's 4.6-billion-year history. The Earth's temperature and weather patterns change naturally over timescales ranging from decades to millions of years. Natural variations in the surface climate originate in two ways. Internal climate fluctuations associated with circulations in the atmosphere and ocean produce exchanges of energy, water, and carbon between the atmosphere, oceans, land, and ice. External influences on the climate system include variations in the energy received from the sun and the effects of volcanic eruptions. Human activities influence climate through changing land use and land cover. Humans are also changing atmospheric composition by increasing the emissions of CO<sub>2</sub> and other greenhouse gases and by altering the concentrations of aerosol particles in the atmosphere.

I think this para puts anthro CO<sub>2</sub> into the appropriate context

On Wed, Apr 23, 2025 at 3:59 AM Roy Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)> wrote:  
All:



I've made some edits to Steve's document (attached).

The first (rather large) edit has to do with the implication that climate change is only due to changes in the radiative energy balance of the Earth, which I (and Dick Lindzen) disagree with. How to handle this, though, is not that obvious to me. I realize we are addressing human influences on climate, but I don't think we should accept such an anthropocentric view of climate change at the outset... This comes up later, too, in the discussion of global radiative forcing since the 1700s... We have no clue what kinds of other energy imbalances (either at the surface or at top-of-atmosphere) might have been occurring due to Nature since the 1700s.

Again, I'm open to suggestions. Maybe such issues are not necessary to mention if even the putative human forcings lead to non-damaging impacts (?)

-Roy

---

**From:** Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>  
**Sent:** Tuesday, April 22, 2025 11:05 PM  
**To:** 'Ross McKittrick' <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>; 'Travis Fisher' <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>; 'John Christy' <[climateman60@gmail.com](mailto:climateman60@gmail.com)>; 'Roy W. Spencer' <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>; 'Judith Curry' <[curry.judith@gmail.com](mailto:curry.judith@gmail.com)>  
**Subject:** RE: Apr 20 update

Attached is my take on an integrated Part 1 (together with a modest introduction). I've incorporated relevant material from others.

1. See if you like the narrative arc, which to me feels pretty natural. Note that the subsections turned out to have somewhat different titles
2. Most problematic for me is the technical level. Trying to avoid too much "Climate 101", but some of the material, particularly in Parts 2 and 3 will get pretty technical
3. I'm feeling like it lacks punch. "So what" is missing
4. Obviously, the mechanics need work. Formatting, citations, better figures, ...
5. If you all aren't too dissatisfied with this, I'd propose doing a similar job on Part 2 in the next few days.

SEK

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**From:** Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>  
**Sent:** Sunday, April 20, 2025 8:09 PM  
**To:** Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>; John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>; Roy W. Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>; Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>; Judith Curry <[curry.judith@gmail.com](mailto:curry.judith@gmail.com)>  
**Subject:** Apr 20 update

I've created a new dropbox folder called April 20 version which contains the revised outline, the associated chapters and the reference list for all my sections. I took the documents done prior to this point and renumbered the files and sections accordingly.

The new outline is (bold denotes draft posted)

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- 14 Estimates of the Social Cost of Carbon
- 15 US vehicle-based CO2 emissions and the global climate

Steve: can you draft 1 & 3?

Judy: hoping you can do 8, 10 and 14 (I have info on 14 as well.)

John I think you have something on 15.

Cheers,  
Ross

--



Judith Curry, President  
CFAN - Climate Forecast Applications Network  
Reno, NV USA  
[curry.judith@cfanclimate.com](mailto:curry.judith@cfanclimate.com) | +1.404.803.2012  
<http://www.cfanclimate.net>

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**From:** Roy Spencer <roywspencer@hotmail.com>  
**Sent:** Wednesday, April 23, 2025 9:37 AM  
**To:** Judith Curry  
**Cc:** Steven Koonin; Ross McKittrick; Travis Fisher; John Christy  
**Subject:** Re: Apr 20 update

Judy's paragraph is more elegant than what I wrote.

-Roy

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**From:** Judith Curry <curry.judith@gmail.com>  
**Sent:** Wednesday, April 23, 2025 7:48 AM  
**To:** Roy Spencer <roywspencer@hotmail.com>  
**Cc:** Steven Koonin <steven.koonin@gmail.com>; Ross McKittrick <ross.mckittrick@gmail.com>; Travis Fisher <travis.scott.fisher@gmail.com>; John Christy <climateman60@gmail.com>  
**Subject:** Re: Apr 20 update

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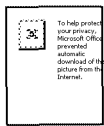
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**Sent:** Wednesday, April 23, 2025 8:59 AM  
**To:** Ross McKitrick  
**Cc:** Roy Spencer; Travis Fisher; John Christy; Judith Curry  
**Subject:** Re: Apr 20 update

Ross-great news.

Roy and Judy- thanks for weighing in. Will push ahead on Part 2 in the same manner.

Steven E. Koonin

On Apr 23, 2025, at 05:49, Ross McKitrick <ross.mckitrick@gmail.com> wrote:

Thanks Steve and Roy. I have a few wording suggestions but am off to a meeting so I'll write later.

Travis and I had a meeting with Secretary Wright yesterday. I'll let Travis provide a more complete summary but my takeaway was:

- Chris was unaware of the problems we had encountered until we briefed him
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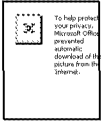
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**Attachments:** Chapter 0 &1 [SEK Apr 22]-RS-edits.docx

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## **0. Introduction**

This document provides technical support for the endangerment and cause or contribute analyses concerning greenhouse gas (GHG) emissions under section 202(a) of the Clean Air Act. It does not convey any judgment or conclusion regarding the question of whether GHGs may be reasonably anticipated to endanger public health or welfare, as this decision is ultimately left to the judgment of the Administrator.

Assessing the dangers created by GHG emissions from US road vehicles involves a long chain of inference.

1. How will emission of GHGs (principally CO<sub>2</sub>) influence the future climate?
2. How will the climate change under those growing influences?
3. How will those changes affect ecosystems and society?

The current certainties and uncertainties in each of these questions are considered in the following three chapters. The presentation is based on official UN and US government assessment reports, the peer reviewed literature and, in some cases, straightforward analyses of official data. However, the usual attribution of climate change to anthropogenic influences involves uncertainties regarding natural sources of climate change, which remain poorly understood. So, while most the following treatment emphasizes the currently popular paradigm of climate change as being due to changes in the global energy balance between absorbed sunlight and emitted heat radiation at the top of the atmosphere, climate can also change from unforced, chaotic variations within the climate system itself, such as atmospheric circulation-induced changes in cloud cover or changes in the rate of overturning of the global oceans. This “known unknown” should be kept in mind in discussions of anthropogenic climate change.

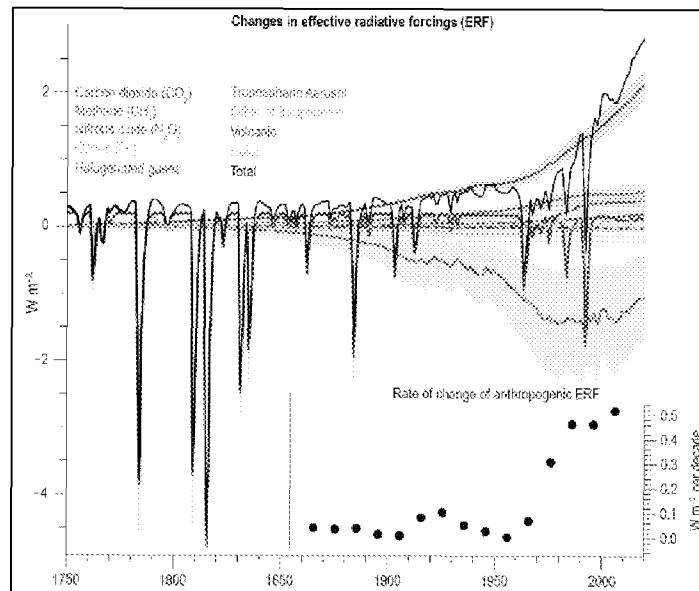
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### **1.1. Radiative forcing**

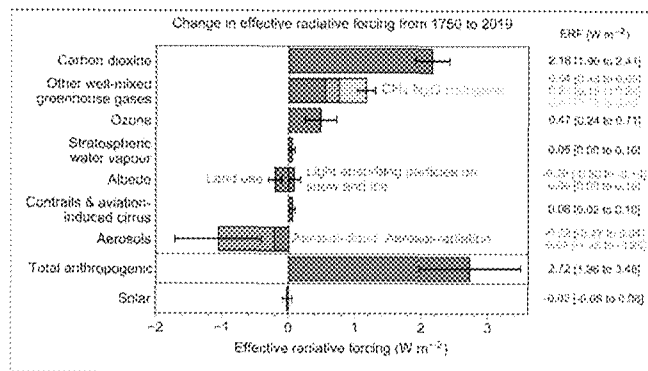
The earth is warmed by the sunlight it absorbs and cooled by the radiative heat it emits to outer space. Averaged over Earth, each of these processes involve power flows of about 240 W/m<sup>2</sup>. When they are in balance, the earth neither warms nor cools and the global temperature is constant. Human (and some natural) influences on the climate alter this balance and so cause the climate to change.

Influences on the climate are quantified by “radiative forcing”, the extent to which they disturb the warming/cooling balance; a positive forcing warms while a negative forcing cools.

The history of total estimated radiative forcing since 1750 and its present-day components are shown in the following two figures from IPCC AR6:



<https://www.ipcc.ch/report/ar6/wg1/figures/chapter-2/figure-2-10/>



<https://www.ipcc.ch/report/ar6/wg1/figures/chapter-7/figure-7-6/>

These graphs show that the total radiative forcing is comprised of natural and anthropogenic components. The natural component is largely volcanic aerosols, which exert an episodic cooling effect; solar variations are deemed negligible. The anthropogenic component was negligible before about 1900 and has increased steadily since, rising to almost 3  $W/m^2$  today. However, this is still only about 1 percent of the unperturbed radiation flows, making it a challenge to isolate the effects of anthropogenic forcing since state-of-the-art satellite estimates of global radiative energy flows are only accurate to a few Watts per sq. meter. Natural sources of global energy imbalance other than volcanoes are not included in these graphs because they remain largely unknown.

Carbon dioxide is the largest human influence on the climate and the one most relevant to the effects of motor vehicles; its emissions are accumulating in the atmosphere, as described in the following section. It exerts a warming influence by decreasing the cooling power of the

atmosphere. Other greenhouse gases (methane, nitrous oxide, halogens, and ozone), which act similarly, currently add another 75% to CO<sub>2</sub>'s warming. Aerosols exert a cooling effect, although with large uncertainties in the way they catalyze the formation of reflective clouds. As a result, understanding of the causes of recent warming is not just through the warming effects of CO<sub>2</sub>, but also the more uncertain cooling effects of sulfate aerosols.

### 1.2. Future radiative forcing

Carbon dioxide's warming influence depends upon how much "extra" CO<sub>2</sub> accumulates in the atmosphere- i.e., it's concentration. The CO<sub>2</sub> level as recorded at the Mauna Loa observatory in Hawaii is generally used as the representative global average concentration. The data are available online at <https://gml.noaa.gov/ccgg/trends/index.html>. The concentration was about 316 ppm at the start of the record in 1959 and is now about 425 ppm, a 34 percent increase.

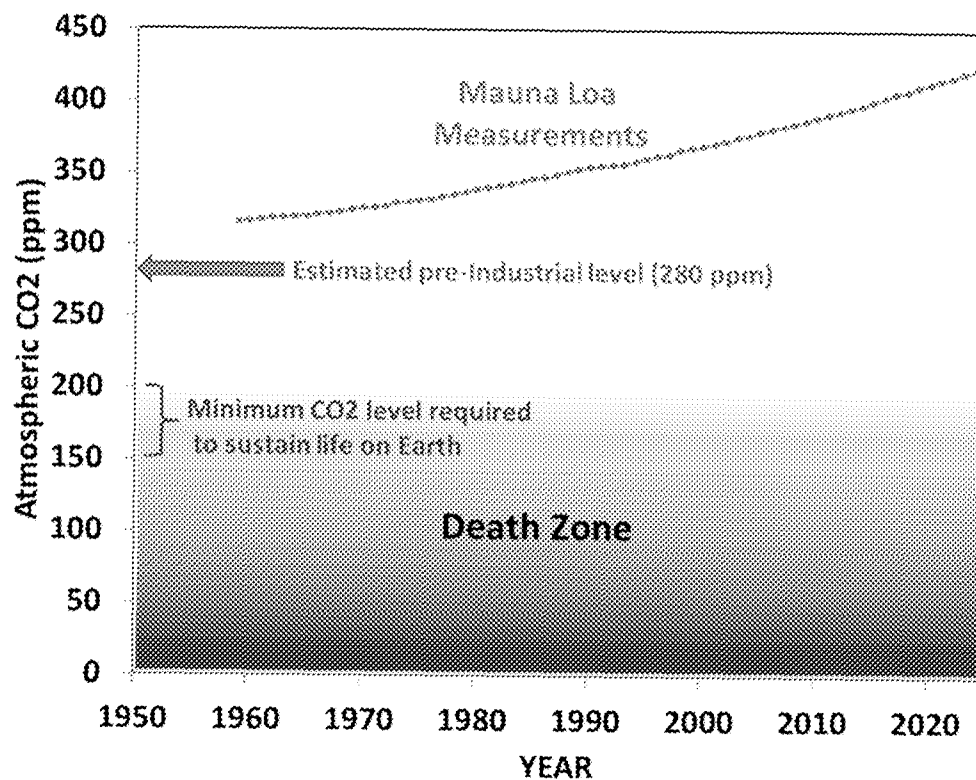


Fig. X. Yearly average atmospheric CO<sub>2</sub> concentrations (1959-2024) measured at Mauna Loa, HI (green) compared to the estimated pre-Industrial CO<sub>2</sub> concentration of 280 ppm, and the estimated minimum levels required to sustain life on Earth (150 to 200 ppm).

The annual increase in concentration is only about half of the CO<sub>2</sub> emitted because land and ocean processes absorb "excess" CO<sub>2</sub> at a rate approximately 50% of human emissions. Thus,

future concentrations, and hence future human influences on the climate, depend upon two components: (1) future rates of global human CO<sub>2</sub> emissions, and (2) how fast the land and ocean remove extra CO<sub>2</sub> from the atmosphere. We discuss each of these in turn.

### **1.2.1. Emissions scenarios**

Assessing the future dangers of GHG emissions requires assumptions about what those emissions will be. Future emissions, and hence human influences on the climate, will depend upon future demographics, economic progress, regulation, and the energy and agricultural technologies in use. Various assumptions about each of those lead to projections of greenhouse gas emissions and concentrations, aerosol concentrations, and changes in land use, which ultimately can be combined into assumptions about anthropogenic radiative forcing.

Because of the great uncertainties about the decades to come, instead of making precise predictions of future concentrations, the IPCC created a set of scenarios meant to span a plausible range of possibilities for population, economy, technology, and so on. Scenarios are labeled by a number indicating the anthropogenic radiative forcing expected in 2100 under that scenario. Thus, a scenario labeled with a “6” corresponds to 6 W/m<sup>2</sup> of human-induced radiative forcing (warming) at the end of the century. (Recall current anthropogenic radiative forcing is about 2.7 W/m<sup>2</sup>.) Unfortunately, IPCC Emission scenarios have long been biased toward excessive warming.

For the IPCC 3<sup>rd</sup> and Fourth Assessment Reports a set of emission projections from the *Special Report on Emission Scenarios* were used, and hence were referred to as the SREP scenarios. McKittrick et al. (2012) showed that, when converted to per capita terms, the SREP scenario distribution was skewed upwards and incompatible with observed trends. McKittrick and Wood (2013) further showed that global energy market dynamics constrained global per capita CO<sub>2</sub> emissions to an extent not reflected in IPCC scenarios. The bias of the SRES scenarios was confirmed by analysis in Hausfather et al. (2019) who showed that observed atmospheric CO<sub>2</sub> levels tracked the lowest of the SRES forecast range.

For the Fifth Assessment Report the IPCC developed a new set of scenarios called the Representative Concentration Pathways (RCP). Each RCP is identified by a number representing the increase in warming forcing in Watts per square meter over the 21<sup>st</sup> century resulting from GHG emissions. The RCP scenarios are thus called RCP2.6, RCP4.5, RCP6.0 and RCP8.5. RCP2.6 (implying a gain of 2.6 Watts per square meter) projects a GHG concentration pathway which implies warming remains well below 2°C. At the other end of the scale RCP8.5 is an extreme outcome implying nearly 5°C warming just in this century.

In both the academic literature and popular media RCP8.5 came to be referred to as the no-policy baseline, or “business-as-usual” scenario. It was used in this way to generate the reference outcome supposedly representing the 21<sup>st</sup> century world in the absence of

emission reduction policies. But RCP8.5 was in fact an extreme high emissions scenario and its usage as a baseline has been grossly misleading. Hausfather and Peters (2020) writing in a commentary in *Nature* magazine, pointed out that RCP8.5 was developed as an extreme worst-case scenario, and its misuse as a “business as usual” baseline has resulted in a large number of misleading studies and media reporting:

RCP8.5 was intended to explore an unlikely high-risk future. But it has been widely used by some experts, policymakers and the media as something else entirely: as a likely ‘business as usual’ outcome. A sizeable portion of the literature on climate impacts refers to RCP8.5 as business as usual, implying that it is probable in the absence of stringent climate mitigation. The media then often amplifies this message, sometimes without communicating the nuances. This results in further confusion regarding probable emissions outcomes, because many climate researchers are not familiar with the details of these scenarios in the energy-modelling literature.

(Hausfather and Peters 2020)

The implausibility of the RCP8.5 scenario was examined by Burgess et al. (2021). They noted that RCP8.5 has already diverged from observed energy use trends, and the near future trends diverge sharply from those of the International Energy Agency (IEA) which provides market-based projections of energy use for coming decades. IEA trends are based on plausible extrapolations of current economic and demographic trends, and the results run below the entire envelope of RCP projections, implying not only that RCP8.5 is dubious, but even lower emission scenarios are looking unlikely. Burgess et al. comment (p. 8):

Beyond 2040, if the trends anticipated by energy agency forecasts continue, carbon intensity will continue diverging from AR5 and SSP baselines—especially from higher-emission scenarios such as RCP8.5, due to the assumptions about fossil-fuel expansion in these scenarios that are increasingly implausible.

The problem of bias towards alarmism in the climate impacts literature fueled by implausible extreme high emission scenarios was confirmed in a literature analysis by Pielke Jr. and Ritchie (2020). They found (p. 32) that between 2010 and 2020 some 16,800 scientific papers had been published using the RCP8.5 scenario, and (p. 16) that about 4,500 of the articles linked RCP8.5 with the concept of “business-as-usual”. They provided analyses of how RCP8.5 was misused not only by individual researchers, but by influential science agencies like the IPCC and the US National Climate Assessment (USNCA), which has directly led to misleading coverage in prominent media outlets. They provide the following example (p. 30):

The USNCA employed RCP8.5 as a baseline scenario, despite warning against such use, and compared it to RCP4.5 throughout its report to generate quantitative economic

estimates of the benefits of mitigation. In a front-page story, the *New York Times* promoted the report's misuse of RCP8.5 as a baseline scenario:

"A major scientific report issued by 13 federal agencies on Friday presents the starkest warnings to date of the consequences of climate change for the United States, predicting that if significant steps are not taken to rein in global warming, the damage will knock as much as 10 percent off the size of the American economy by century's end."

Pielke and Ritchie (2020) reported new studies using RCP8.5 were appearing in the literature at a rate of about 20 per day, with about two per day specifically linking RCP8.5 and "business as usual." They conclude (p. 34) that the climate research community has spent a decade "committing scientific resources to science fiction" (emphasis added):

"Derived estimates from RCP8.5 as "business as usual" such as future climate impacts, the impacts avoided from mitigation and the cost effectiveness and benefits of mitigation have no real-world meaning... **The scientific literature has become imbalanced in an apocalyptic direction.**

(Pielke Jr. and Ritchie p. 34)

The IPCC later modified the RCP scenarios to the "Shared Socioeconomic Pathway" or SSP scenarios, but these have continued the pattern of bias shown with the RCP and SRES scenarios. Figure 1.4.3.2, generated using the Resources for the Future Global Energy Outlook tool (RFF 2025). The black line shows total global observed CO<sub>2</sub> emissions from the International Energy Agency (IEA). The solid green line is the emission trajectory developed by BP energy taking account of current emission control policies and global energy use outlooks. current policy proposals. It overlaps a solid black line which represents the emission projection from the IEA also taking account of energy use projections and current policies. The dashed lines show the range of IPCC SSP policies.

Carbon dioxide emissions (Million metric tons), by Outlooks & Scenarios. Filtered by Region: World; Fuel: All; Outlook: 2023 Shell (Sky 2050).

Source: RFF Global Energy Outlook at [www.rff.org/geo](http://www.rff.org/geo)

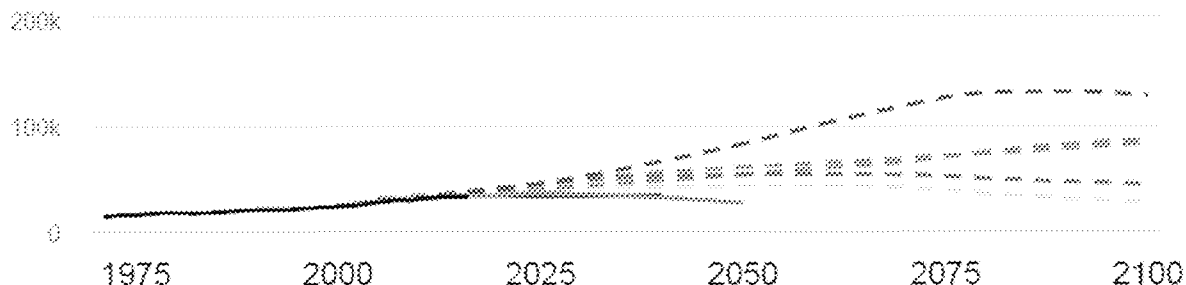
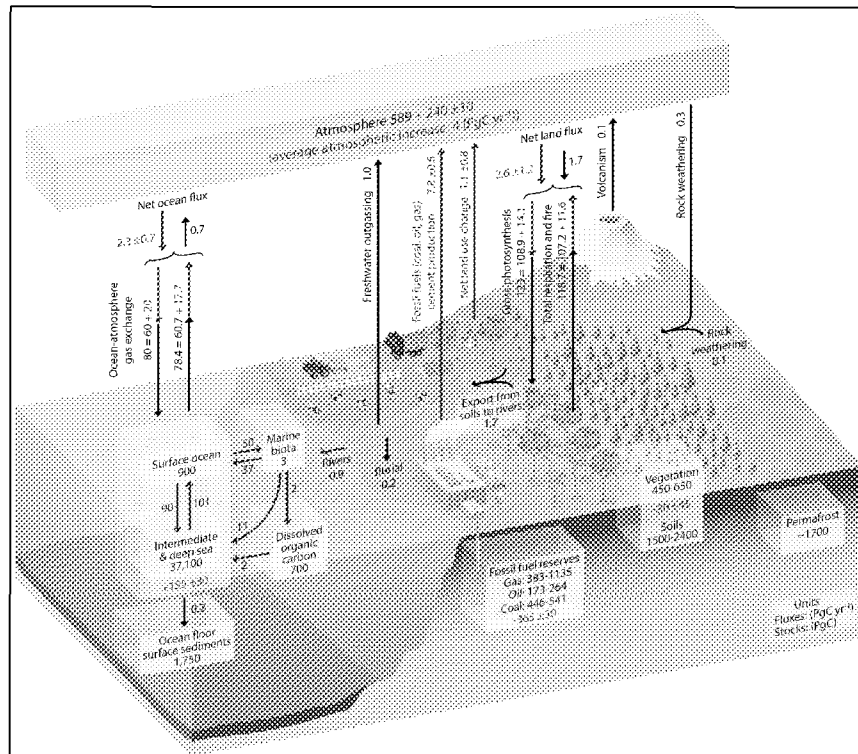


Figure 1.4.3.2. Observed and projected CO<sub>2</sub> emissions. Source: RFF (2025).

As of 2023 global CO<sub>2</sub> emissions have been tracking *well below* the SSP scenarios especially the two highest ones (SSP5-8.5 and SSP3-7.0). As mentioned, most of the climate model projections relied upon for energy policy decisions have been from these two emissions scenarios or their RCP analogues, which exaggerated and unrealistic (e.g. Ritchie and Dowlatabadi, 2017; Pielke & Ritchie, 2017; Pielke & Ritchie, 2021).

### 1.2.2. The carbon cycle relating emissions and concentrations





Global carbon cycle models relate concentrations to emissions using estimates of various land and ocean processes that remove CO<sub>2</sub> from, and emit CO<sub>2</sub> into, the atmosphere. Our understanding of these processes was reviewed by Crisp et al. (2021). The natural fluxes of CO<sub>2</sub> in and out of the Earth's surface are very large, many times anthropogenic emissions, but those CO<sub>2</sub> sources and sinks were assumed to be in approximate balance in pre-Industrial times, as evidenced by relatively constant levels of atmospheric CO<sub>2</sub> in centuries past derived from air bubbles in ice cores. This is one of several reasons why increasing atmospheric CO<sub>2</sub> levels are believed to be dominated by anthropogenic sources.

Specifically, fossil fuel burning (and to a lesser extent land use [biomass burning] and cement production) has led to steadily increasing CO<sub>2</sub> levels in the atmosphere, as shown in Fig.X

CO<sub>2</sub> emissions from fossil fuel burning is a small fraction of the natural carbon cycle components. About 44,000 Gigatonnes of carbon-equivalent (GtC) are stored in the atmosphere and oceans, mostly in the form of CO<sub>2</sub>. (Ciais et al. 2013). Between 150 and 200 GtC are released naturally each year through oceanic outgassing and land-based processes like plant decay and animal respiration. A variable but roughly equivalent amount is absorbed each year by the land and oceans, with a small net loss from the atmosphere because the formation of deep ocean sediment sequesters some carbon permanently. Global fossil fuel consumption and cement manufacture released about 10.3 GtC in 2023, up from 6.2 GtC in 1990 (Ritchie et al. 2024). Of this, about half is naturally sequestered through plant

growth and oceanic uptake while the remainder, about half, adds to the atmospheric stock (Ciais et al. 2013).

As noted, each year natural processes remove a net amount of CO<sub>2</sub> equivalent to about 50% of global emissions. Thus, anthropogenic CO<sub>2</sub> emissions average twice what is required to explain the atmospheric rise in CO<sub>2</sub> concentration. The near-constancy of that 50% fraction (the “airborne fraction”) also means that the more CO<sub>2</sub> humanity produces, the faster Nature removes it from the atmosphere. That 50% fraction changes somewhat from year to year due to natural carbon cycle imbalances from El Nino, La Nina, and varying weather patterns. There was also a substantial additional reduction in atmospheric CO<sub>2</sub> after the 1991 eruption of Mt. Pinatubo, a curious result that has yet to be explained (Angert et al., 2004).

The main processes which remove excess CO<sub>2</sub> from the atmosphere are increased production of land vegetation (especially at high latitudes), some increase in the sequestering of carbon in soils, and uptake of CO<sub>2</sub> by the ocean due to the increasing partial pressure of atmospheric CO<sub>2</sub> over that of CO<sub>2</sub> dissolved in the ocean. All twenty land carbon cycle models tracked by the Global Carbon Project (Friedlingstein et al., 2024) show land processes have been removing excess CO<sub>2</sub> at an increasing rate since 1959. This is consistent with a “global greening” phenomenon observed by satellites since monitoring of global greenness began in the 1982. This greening has been traced to CO<sub>2</sub> fertilization and greater drought tolerance of plants exposed to elevated CO<sub>2</sub> levels. While there had been some uncertainty whether a greening trend continued beyond 2000, the most recent research (Chen et al., 2023) has shown continued greening, with even some slight acceleration since 2000. Global greening is discussed further in Section 3.1.

While land vegetation has been responding positively to more atmospheric CO<sub>2</sub>, uptake of extra CO<sub>2</sub> by ocean biological processes remains too uncertain to be reliably measured. Our current understanding of these and many more carbon cycle processes was reviewed by Crisp et al. (2021).

### **1.3. CO<sub>2</sub> as a “pollutant”**

Whether CO<sub>2</sub> falls in the legal category of pollutant is ultimately a legal question. But the answer should be informed by the scientific similarities and differences between CO<sub>2</sub> and other generally acknowledged pollutants.

CO<sub>2</sub> is fundamentally different from criterion air contaminants like SO<sub>2</sub> and NO<sub>x</sub> for two reasons. First, the damage from criterion air contaminants stems from their local ground-level concentration, since that is what affects human welfare. But local variations in CO<sub>2</sub> levels do not affect human health, the potential channel of influence is through variations in the global climate which operates through the global average atmospheric CO<sub>2</sub> concentration.

(Another influence is the positive local effect on crop productivity which will be discussed in Section 3.2).

The second reason is that policy can only change the rate of emissions, not the concentration in the atmosphere. For criterion air contaminants the rate and concentration are closely connected because the lifetime is short and the concentration is small. When emissions are reduced the local pollution concentration drops rapidly, usually on a time scale of a few days. Not so with the global average CO<sub>2</sub> concentration since global carbon cycle is vast and slow. A change in local emissions today will only have a very small global effect, and only after a long time lag. After a pulse (release) of CO<sub>2</sub> emissions to the atmosphere only about 40 percent ( $\pm 15\%$ ) of the extra CO<sub>2</sub> will have been sequestered after twenty years. After a thousand years about 75 percent ( $\pm 10\%$ ) will have been sequestered, and the remainder will gradually be removed over the ensuing tens of thousands of years (Ciais et al. 2013, pp. 472-473). Consequently US CO<sub>2</sub> emission reductions will take decades or centuries to lead to a reduction in the global CO<sub>2</sub> concentration.

To reduce the atmospheric stock of CO<sub>2</sub>, assuming the entire increase is anthropogenic, would require emissions to fall below the natural sequestration rate. Since that rate has been averaging about 50% of emissions, a reduction of global emissions by 50% would (at least temporarily) halt the rise in atmospheric CO<sub>2</sub>. The 1997 Kyoto Protocol proposed to cap industrial nations' CO<sub>2</sub> emissions at a modest five percent below 1990 levels by the year 2012. Even though this policy ended up too costly for most nations to implement, full compliance would not have substantially reduced atmospheric CO<sub>2</sub> levels. They would only slightly slowed CO<sub>2</sub> growth, reaching their projected 2100 level in 2105 instead (Wigley 1998). Similarly, Lomborg (2016) used the widely-used MAGICC climate model and showed that full compliance with the Paris Accord would delay hitting the baseline year 2100 levels about a decade later instead.

Thus, in contrast with conventional air pollution control, local actions yield extremely small local effects, and only after a long time lag. The practice of referring to unilateral US reductions as “combatting climate change” or “taking action on climate” reflects a profound misunderstanding of the scale of the issue.

#### **1.4. Summary**

- When the two components required to estimate future atmospheric CO<sub>2</sub> concentrations are combined (anthropogenic emissions estimates along with carbon cycle model estimates of atmospheric CO<sub>2</sub> removal), we get estimates of future CO<sub>2</sub> concentrations and hence the radiative forcings required by climate models to estimate future rates of warming.
- For decades the IPCC has used emission scenario envelopes that are grossly exaggerated against observed trends.

- The vast majority of academic climate “impacts” studies in recent years are based on scenarios like RCP8.5 that are implausible to the point of being deceitful. Usage of the RCP8.5 scenario amplifies the putative dangers of future baseline emissions and exaggerates the associated benefits of emission reduction policies.
- Despite ample evidence that scenario envelopes are exaggerated, and despite heavy criticism of this practice in the peer-reviewed literature, the IPCC’s most recent scenario set called SSP carries on with this deceptive pattern.
- Unlike criterion air contaminants, local emissions and local levels of CO<sub>2</sub> have no human health implications. The only potential effects are CO<sub>2</sub> fertilization of plants (a benefit) and modifications of the global climate.
- The global carbon cycle heavily dampens the effect of changes in local (e.g. U.S.) CO<sub>2</sub> emissions. Even global-scale emission reductions will have only small effects, long in the future.

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**From:** Steven Koonin <steven.koonin@gmail.com>  
**Sent:** Wednesday, April 23, 2025 12:05 AM  
**To:** 'Ross McKittrick'; 'Travis Fisher'; 'John Christy'; 'Roy W. Spencer'; 'Judith Curry'  
**Subject:** RE: Apr 20 update  
**Attachments:** Chapter 0 &1 [SEK Apr 22].docx

Attached is my take on an integrated Part 1 (together with a modest introduction). I've incorporated relevant material from others.

1. See if you like the narrative arc, which to me feels pretty natural. Note that the subsections turned out to have somewhat different titles
2. Most problematic for me is the technical level. Trying to avoid too much "Climate 101", but some of the material, particularly in Parts 2 and 3 will get pretty technical
3. I'm feeling like it lacks punch. "So what" is missing
4. Obviously, the mechanics need work. Formatting, citations, better figures, ...
5. If you all aren't too dissatisfied with this, I'd propose doing a similar job on Part 2 in the next few days.

SEK

---

**From:** Ross McKittrick <ross.mckittrick@gmail.com>  
**Sent:** Sunday, April 20, 2025 8:09 PM  
**To:** Travis Fisher <travis.scott.fisher@gmail.com>; John Christy <climateman60@gmail.com>; Roy W. Spencer <roywspencer@hotmail.com>; Steven Koonin <steven.koonin@gmail.com>; Judith Curry <curry.judith@gmail.com>  
**Subject:** Apr 20 update

I've created a new dropbox folder called April 20 version which contains the revised outline, the associated chapters and the reference list for all my sections. I took the documents done prior to this point and renumbered the files and sections accordingly.

The new outline is (bold denotes draft posted)

Part I: Human influence on the climate

- 1 Components of anthropogenic radiative forcing and their history to date
- 2 The carbon cycle and future emission scenarios**
- 3 Aerosols and the uncertainties associated with them

Part II: Climate response to anthropogenic influence

- 4 Measuring climate sensitivity to CO2 doubling**
- 5 Models versus observations in recent past**
- 6 Uncertainties in analysis of attribution**
- 7 Evidence on trends and attributable changes in extreme weather**
- 8 Sea level rise

Part III: Impacts on ecosystems and society

- 9 Managing risks of extreme weather**
- 10 Mortality risk from extreme heat and cold

**11 Climate change and US agriculture**

12 Climate change and global greening

**13 Climate change and economic growth**

14 Estimates of the Social Cost of Carbon

15 US vehicle-based CO2 emissions and the global climate

Steve: can you draft 1 & 3?

Judy: hoping you can do 8, 10 and 14 (I have info on 14 as well.)

John I think you have something on 15.

Cheers,

Ross

## **0. Introduction**

This document provides technical support for the endangerment and cause or contribute analyses concerning greenhouse gas (GHG) emissions under section 202(a) of the Clean Air Act. It does not convey any judgment or conclusion regarding the question of whether GHGs may be reasonably anticipated to endanger public health or welfare, as this decision is ultimately left to the judgment of the Administrator.

Assessing the dangers created by GHG emissions from US road vehicles involves a long chain of inference.

1. How will emission of GHGs (principally CO<sub>2</sub>) influence the future climate?
2. How will the climate change under those growing influences?
3. How will those changes affect ecosystems and society?

The current certainties and uncertainties in each of these questions are considered in the following three chapters. The presentation is based on official UN and USG assessment reports, the peer reviewed literature and, in some cases, straightforward analyses of official data.

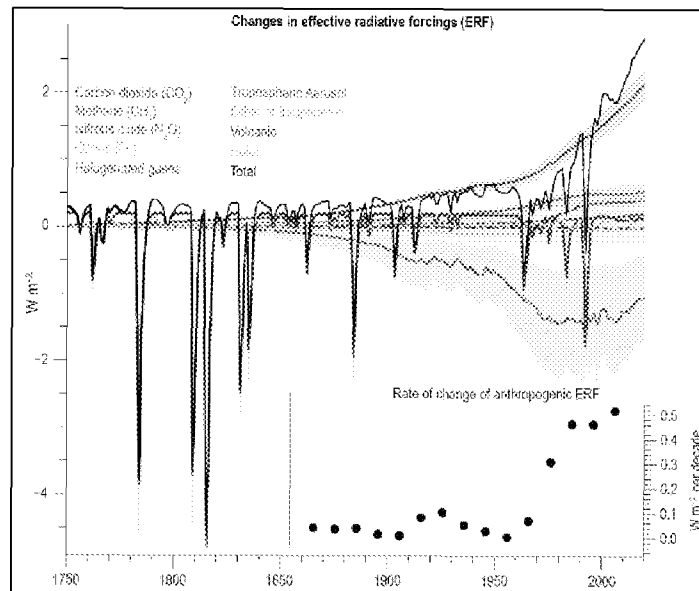
### **1. Human influences on the climate**

#### **1.1. Radiative forcing**

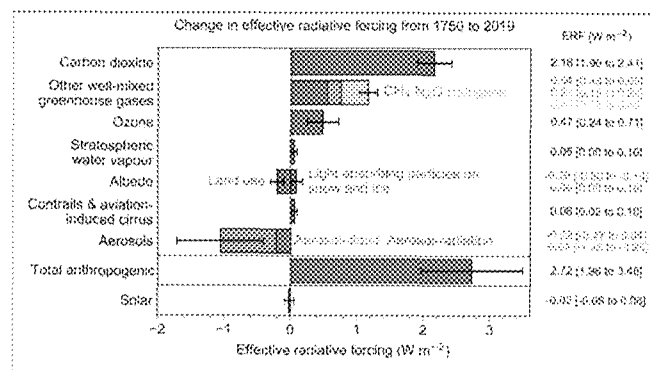
The earth is warmed by the sunlight it absorbs and cooled by the heat it emits. Averaged over the earth, each of these processes involve power flows of about 240 W/m<sup>2</sup>. When they are in balance, the earth neither warms nor cools and the global temperature is constant. Human (and some natural) influences on the climate alter this balance and so cause the climate to change in ways beyond its natural variability.

Influences on the climate are quantified by “radiative forcing”, the extent to which they disturb the warming/cooling balance; a positive forcing warms while a negative forcing cools.

The history of total radiative forcing since 1750 and its present-day components are shown in the following two figures from IPCC AR6:



<https://www.ipcc.ch/report/ar6/wg1/figures/chapter-2/figure-2-10/>



<https://www.ipcc.ch/report/ar6/wg1/figures/chapter-7/figure-7-6/>

These graphs show that the total forcing is comprised of natural and anthropogenic components. The natural component is largely volcanic aerosols, which exert an episodic cooling effect; solar variations are deemed negligible. The anthropogenic component was negligible before about 1900 and has increased steadily since, rising to almost 3  $W/m^2$  today. However, this is still only about 1 percent of the unperturbed radiation flows, making it a challenge to isolate the effects of anthropogenic forcing.

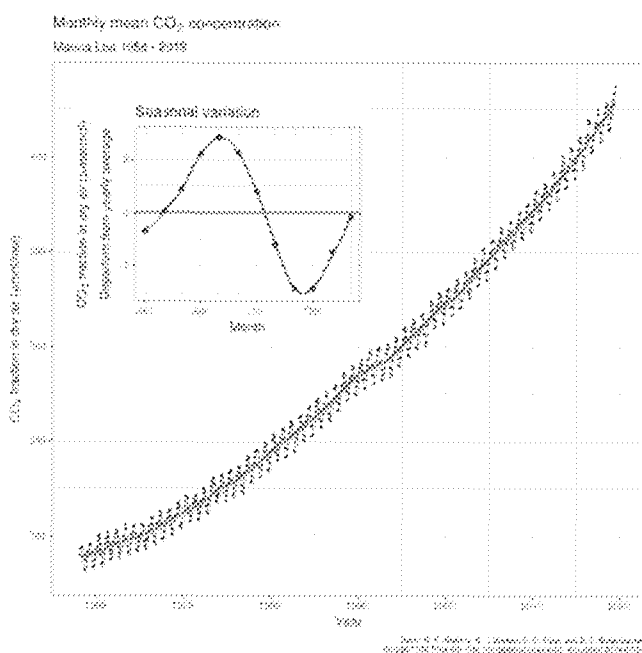
Carbon dioxide is the largest human influence on the climate and the one most relevant to the effects of motor vehicles; its emissions are accumulating in the atmosphere, as described in the following section. It exerts a warming influence by decreasing the cooling power of the atmosphere. Other greenhouse gases (methane, nitrous oxide, halogens, and ozone), which act similarly, currently add another 75% to  $CO_2$ 's warming. Aerosols exert a cooling effect, although with large uncertainties in the way they catalyze the formation of reflective clouds. As a result,



understanding of the causes of recent warming is not just through the warming effects of CO<sub>2</sub>, but also the more uncertain cooling effects of sulfate aerosols.

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[**add to caption:** life on Earth requires CO<sub>2</sub> levels of at least 150 to 200 ppm. This is because the food chains on land and in the ocean begin with vegetation and biota that depend upon photosynthesis, which requires CO<sub>2</sub>. ]

The annual increase in concentration is only about half of the CO<sub>2</sub> emitted because there is a complex annual cycle that redistributes carbon between the atmosphere and the earth's surface. Thus, future concentrations, and hence future human influences on the climate, depend upon two components: (1) future rates of global human CO<sub>2</sub> emissions, and (2) how fast the land and ocean remove extra CO<sub>2</sub> from the atmosphere. We discuss each of these in turn.

### 1.2.1. Emissions scenarios

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Beyond 2040, if the trends anticipated by energy agency forecasts continue, carbon intensity will continue diverging from AR5 and SSP baselines—especially from higher-emission scenarios such as RCP8.5, due to the assumptions about fossil-fuel expansion in these scenarios that are increasingly implausible.

The problem of bias towards alarmism in the climate impacts literature fueled by implausible extreme high emission scenarios was confirmed in a literature analysis by Pielke Jr. and Ritchie (2020). They found (p. 32) that between 2010 and 2020 some 16,800 scientific papers had been published using the RCP8.5 scenario, and (p. 16) that about 4,500 of the articles linked RCP8.5 with the concept of “business-as-usual”. They provided analyses of how RCP8.5 was misused not only by individual researchers, but by influential science agencies like the IPCC and the US National Climate Assessment (USNCA), which has directly led to misleading coverage in prominent media outlets. They provide the following example (p. 30):

The USNCA employed RCP8.5 as a baseline scenario, despite warning against such use, and compared it to RCP4.5 throughout its report to generate quantitative economic estimates of the benefits of mitigation. In a front page story, the *New York Times* promoted the report’s misuse of RCP8.5 as a baseline scenario:

“A major scientific report issued by 13 federal agencies on Friday presents the starkest warnings to date of the consequences of climate change for the United

States, predicting that if significant steps are not taken to rein in global warming, the damage will knock as much as 10 percent off the size of the American economy by century's end."

Pielke and Ritchie (2020) reported new studies using RCP8.5 were appearing in the literature at a rate of about 20 per day, with about two per day specifically linking RCP8.5 and "business as usual." They conclude (p. 34) that the climate research community has spent a decade "committing scientific resources to science fiction" (emphasis added):

"Derived estimates from RCP8.5 as "business as usual" such as future climate impacts, the impacts avoided from mitigation and the cost effectiveness and benefits of mitigation have no real-world meaning... **The scientific literature has become imbalanced in an apocalyptic direction.**

(Pielke Jr. and Ritchie p. 34)

The IPCC later modified the RCP scenarios to the "Shared Socioeconomic Pathway" or SSP scenarios, but these have continued the pattern of bias shown with the RCP and SRES scenarios. Figure 1.4.3.2, generated using the Resources for the Future Global Energy Outlook tool (RFF 2025). The black line shows total global observed CO<sub>2</sub> emissions from the International Energy Agency (IEA). The solid green line is the emission trajectory developed by BP energy taking account of current emission control policies and global energy use outlooks. current policy proposals. It overlaps a solid black line which represents the emission projection from the IEA also taking account of energy use projections and current policies. The dashed lines show the range of IPCC SSP policies.

Carbon dioxide emissions (Million metric tons), by Outlooks & Scenarios. Filtered by Region: World; Fuel: All; Outlook: 2023 Shell (Sky 2050).

Source: RFF Global Energy Outlook at [www.rff.org/geo](http://www.rff.org/geo)

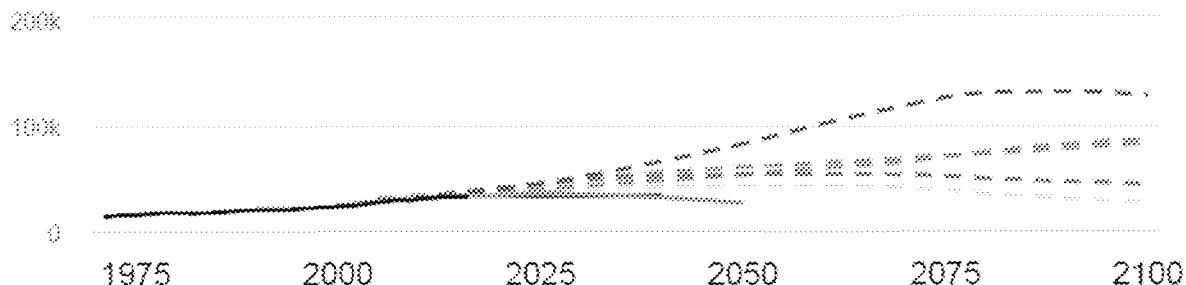
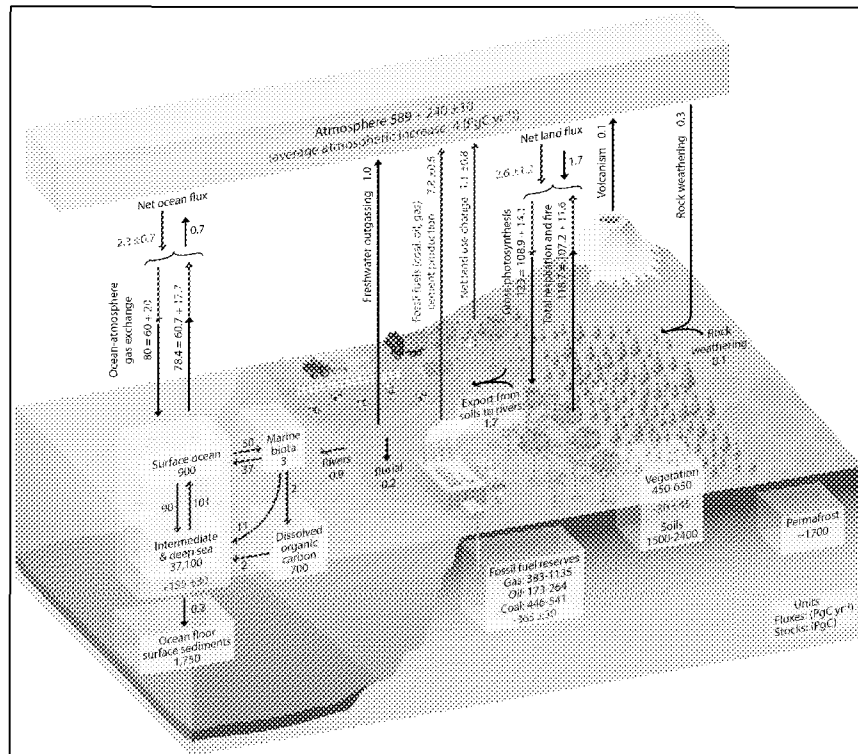


Figure 1.4.3.2. Observed and projected CO<sub>2</sub> emissions. Source: RFF (2025).

As of 2023 global CO<sub>2</sub> emissions have been tracking *well below* the SSP scenarios especially the two highest ones (SSP5-8.5 and SSP3-7.0). As mentioned, most of the climate model projections relied upon for energy policy decisions have been from these two emissions scenarios or their RCP analogues, which exaggerated and unrealistic (e.g. Ritchie and Dowlatabadi, 2017; Pielke & Ritchie, 2017; Pielke & Ritchie, 2021).

### 1.2.2. The carbon cycle relating emissions and concentrations



Global carbon cycle models relate concentrations to emissions using estimates of various land and ocean processes that remove CO<sub>2</sub> from, and emit CO<sub>2</sub> into, the atmosphere. Our understanding of these processes was reviewed by Crisp et al. (2021). The natural fluxes of CO<sub>2</sub> in and out of the Earth's surface are very large, many times anthropogenic emissions, but those CO<sub>2</sub> sources and sinks were assumed to be in approximate balance in pre-Industrial times, as evidenced by relatively constant levels of atmospheric CO<sub>2</sub> in centuries past derived from air bubbles in ice cores. This is one of several reasons why increasing atmospheric CO<sub>2</sub> levels are believed to be dominated by anthropogenic sources.

Specifically, fossil fuel burning (and to a lesser extent land use [biomass burning] and cement production) has led to steadily increasing CO<sub>2</sub> levels in the atmosphere, as shown in Fig.X

CO<sub>2</sub> emissions from fossil fuel burning is a small component of the natural carbon cycle. About 44,000 Gigatonnes of carbon-equivalent (GtC) are stored in the atmosphere and oceans, mostly in the form of CO<sub>2</sub>. (Ciais et al. 2013). Between 150 and 200 GtC are released naturally each year through oceanic outgassing and land-based processes like plant decay and animal respiration. A variable but roughly equivalent amount is absorbed each year by the land and oceans, with a small net loss from the atmosphere because the formation of deep ocean sediment sequesters some carbon permanently. Global fossil fuel consumption and cement manufacture released about 10.3 GtC in 2023, up from 6.2 GtC in 1990 (Ritchie

et al. 2024). Of this, about half is naturally sequestered through plant growth and oceanic uptake while the remainder, about half, adds to the atmospheric stock (Ciais et al. 2013).

As noted, each year natural processes remove a net amount of CO<sub>2</sub> equivalent to about 50% of global emissions. Thus, anthropogenic CO<sub>2</sub> emissions average twice what is required to explain the atmospheric rise in CO<sub>2</sub> concentration. The near-constancy of that 50% fraction (the “airborne fraction”) also means that the more CO<sub>2</sub> humanity produces, the faster Nature removes it from the atmosphere. That 50% fraction changes somewhat from year to year due to natural carbon cycle imbalances from El Nino, La Nina, and varying weather patterns. There was also a substantial additional reduction in atmospheric CO<sub>2</sub> after the 1991 eruption of Mt. Pinatubo, a curious result that has yet to be explained (Angert et al., 2004).

The main processes which remove excess CO<sub>2</sub> from the atmosphere are increased production of land vegetation (especially at high latitudes), some increase in the sequestering of carbon in soils, and uptake of CO<sub>2</sub> by the ocean due to the increasing partial pressure of atmospheric CO<sub>2</sub> over that of CO<sub>2</sub> dissolved in the ocean. All twenty land carbon cycle models tracked by the Global Carbon Project (Friedlingstein et al., 2024) show land processes have been removing excess CO<sub>2</sub> at an increasing rate since 1959. This is consistent with a “global greening” phenomenon observed by satellites since monitoring of global greenness began in the 1982. This greening has been traced to CO<sub>2</sub> fertilization and greater drought tolerance of plants exposed to elevated CO<sub>2</sub> levels. While there had been some uncertainty whether a greening trend continued beyond 2000, the most recent research (Chen et al., 2023) has shown continued greening, with even some slight acceleration since 2000. Global greening is discussed further in Section 3.1.

While land vegetation has been responding positively to more atmospheric CO<sub>2</sub>, uptake of extra CO<sub>2</sub> by ocean biological processes remains too uncertain to be reliably measured. Our current understanding of these and many more carbon cycle processes was reviewed by Crisp et al. (2021).

### **1.3. CO<sub>2</sub> as a “pollutant”**

Whether CO<sub>2</sub> falls in the legal category of pollutant is ultimately a legal question. But the answer should be informed by the scientific similarities and differences between CO<sub>2</sub> and other generally acknowledged pollutants.

CO<sub>2</sub> is fundamentally different from criterion air contaminants like SO<sub>2</sub> and NO<sub>x</sub> for two reasons. First, the damage from criterion air contaminants stems from their local ground-

level concentration, since that is what affects human welfare. But local variations in CO<sub>2</sub> levels do not affect human health, the potential channel of influence is through variations in the global climate which operates through the global average atmospheric CO<sub>2</sub> concentration. (Another influence is the positive local effect on crop productivity which will be discussed in Section 3.2).

The second reason is that policy can only change the rate of emissions, not the concentration in the atmosphere. For criterion air contaminants the rate and concentration are closely connected because the lifetime is short and the concentration is small. . When emissions are reduced the local pollution concentration drops rapidly, usually on a time scale of a few days. Not so with the global average CO<sub>2</sub> concentration since global carbon cycle is vast and slow. A change in local emissions today will only have a very small global effect, and only after a long time lag. After a pulse (release) of CO<sub>2</sub> emissions to the atmosphere only about 40 percent ( $\pm 15\%$ ) of the emitted molecules will have been sequestered after twenty years. After a thousand years about 75 percent ( $\pm 10\%$ ) will have been sequestered, and the remainder will gradually be removed over the ensuing tens of thousands of years (Ciais et al. 2013, pp. 472-473). Consequently US CO<sub>2</sub> emission reductions will take decades or centuries to lead to a reduction in the global CO<sub>2</sub> concentration.

To reduce the atmospheric stock of CO<sub>2</sub>, assuming the entire increase is anthropogenic, would require emissions to fall below the natural sequestration rate. The 1997 Kyoto Protocol proposed to cap industrial nations' CO<sub>2</sub> emissions at five percent below 1990 levels by the year 2012. Even though this policy ended up too costly for most nations to implement, full compliance would not have reduced atmospheric CO<sub>2</sub> levels. They would only have slowed down slightly slowly, reaching their projected 2100 level in 2105 instead (Wigley 1998). Similarly Lomborg (2016) used the well-known MAGICC climate model and showed that full compliance with the Paris Accord would delay hitting the baseline year 2100 levels about a decade later instead.

Thus, in contrast with conventional air pollution control, local actions yield extremely small local effects, and only after a long time lag. The practice of referring to unilateral US reductions as “combatting climate change” or “taking action on climate” reflects a profound misunderstanding of the scale of the issue.

#### **1.4. Summary**

- When the two components required to estimate future atmospheric CO<sub>2</sub> concentrations are combined (anthropogenic emissions estimates along with carbon cycle model estimates of atmospheric CO<sub>2</sub> removal), we get estimates of future CO<sub>2</sub> concentrations and hence the radiative forcings required by climate models to estimate future rates of warming.



- For decades the IPCC has used emission scenario envelopes that are grossly exaggerated against observed trends.
- The vast majority of academic climate “impacts” studies in recent years are based on scenarios like RCP8.5 that are implausible to the point of misleading. Usage of the RCP8.5 scenario amplifies the putative dangers of future baseline emissions and exaggerates the associated benefits of emission reduction policies.
- Despite ample evidence that scenario envelopes are exaggerated, and despite heavy criticism of this practice in the peer-reviewed literature, the IPCC’s most recent scenario set called SSP carries on with this deceptive pattern.
- Unlike criterion air contaminants, local emissions and local levels of CO<sub>2</sub> have no human health implications. The only potential effects are CO<sub>2</sub> fertilization of plants (a benefit) and modifications of the global climate.
- The global carbon cycle heavily dampens the effect of changes in local CO<sub>2</sub> emissions. Even global-scale emission reductions will have only small effects, long in the future.

---

**From:** Steven Koonin <steven.koonin@gmail.com>  
**Sent:** Monday, April 21, 2025 5:59 AM  
**To:** 'Ross McKittrick'; 'Travis Fisher'; 'John Christy'; 'Roy W. Spencer'; 'Judith Curry'  
**Subject:** RE: Apr 20 update

Yes, I'll take on 1 and 3 and, more generally, an integrated Part I. Given schedule (booked up today, flying to the West Coast tomorrow), I expect to send something around by COB (West Coast) tomorrow.

SEK

---

**From:** Ross McKittrick <ross.mckittrick@gmail.com>  
**Sent:** Sunday, April 20, 2025 8:09 PM  
**To:** Travis Fisher <travis.scott.fisher@gmail.com>; John Christy <climateman60@gmail.com>; Roy W. Spencer <roywspencer@hotmail.com>; Steven Koonin <steven.koonin@gmail.com>; Judith Curry <curry.judith@gmail.com>  
**Subject:** Apr 20 update

I've created a new dropbox folder called April 20 version which contains the revised outline, the associated chapters and the reference list for all my sections. I took the documents done prior to this point and renumbered the files and sections accordingly.

The new outline is (bold denotes draft posted)

Part I: Human influence on the climate

- 1 Components of anthropogenic radiative forcing and their history to date
- 2 The carbon cycle and future emission scenarios**
- 3 Aerosols and the uncertainties associated with them

Part II: Climate response to anthropogenic influence

- 4 Measuring climate sensitivity to CO2 doubling**
- 5 Models versus observations in recent past**
- 6 Uncertainties in analysis of attribution**
- 7 Evidence on trends and attributable changes in extreme weather**
- 8 Sea level rise

Part III: Impacts on ecosystems and society

- 9 Managing risks of extreme weather**
- 10 Mortality risk from extreme heat and cold
- 11 Climate change and US agriculture**
- 12 Climate change and global greening
- 13 Climate change and economic growth**
- 14 Estimates of the Social Cost of Carbon
- 15 US vehicle-based CO2 emissions and the global climate

Steve: can you draft 1 & 3?

Judy: hoping you can do 8, 10 and 14 (I have info on 14 as well.)

John I think you have something on 15.

Cheers,  
Ross

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**From:** Ross McKittrick <ross.mckittrick@gmail.com>  
**Sent:** Sunday, April 20, 2025 8:09 PM  
**To:** Travis Fisher; John Christy; Roy W. Spencer; Steven Koonin; Judith Curry  
**Subject:** Apr 20 update

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**From:** Travis Fisher <travis.scott.fisher@gmail.com>  
**Sent:** Monday, April 14, 2025 2:58 PM  
**To:** Steven Koonin  
**Cc:** Ross McKittrick; John Christy; roywspencer@hotmail.com  
**Subject:** Re: Kickoff

Excellent, thank you!

Yes, if you all have something to contribute to the definition of an air pollutant, I'd like to convey that to policymakers. I have no idea whether or not it will be included in whatever is ultimately published. One reason I ask is that the majority opinion in *Mass v. EPA* doesn't make sense to me -- it seems to over-include some classes of emissions that (to me, at least) are clearly not air pollutants. For example, both hydrocarbon- and hydrogen-fueled vehicles emit water vapor, but I'm not sure how many policymakers would find that water vapor is an air pollutant. Or is there a quantity threshold at which even water vapor becomes an air pollutant? These are the types of questions I expect to be part of the litigation, and any scientific input would be helpful to the policymaking process.

I look forward to helping this work get across the near-term finish line. If you have any questions about what's next or where your own paperwork is, etc., please call me anytime at 202-302-9953. For anyone who wants to continue to contribute to this project beyond this month, I am happy to report that we are figuring out ways to bring you on as a paid contractor. Special Government Employee status is a bit trickier, but we can likely make that work as well.

Also, I should clarify that I only play an attorney on TV. I appreciate the promotion from Steve, but I am not a lawyer (just an economist, and I'm not sure which is worse!).

Best,  
Travis

On Mon, Apr 14, 2025 at 2:53 PM Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)> wrote:  
We need to be careful if we get into the issue of "what is/isn't a pollutant"

That's ultimately a legal question and we're not lawyers (well, Travis is).

I think we can legitimately compare/contrast the various properties of the pollutants cited (and water vapor!) such as effect, potency, lifetime, dispersion, ... That's consistent with our providing technical input.

But we shouldn't make any judgements - leave that for the lawyers and policy makers.

Steven Koonin (from New Delhi)

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Hi Travis

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Here is a Dropbox link that contains the current outline (also attached) which indicates who is working on each section

[https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyrr8x/ANTU1qAQJ-zXCFzP\\_gsJcOs?rlkey=11z3qj9v46e1t5f4ywwxq7p8c&dl=0](https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyrr8x/ANTU1qAQJ-zXCFzP_gsJcOs?rlkey=11z3qj9v46e1t5f4ywwxq7p8c&dl=0)

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I put folders in there for each of us. If the use of that Dropbox (which is on my own account) is acceptable for this project then we can share our work using it. Otherwise once we have an official Dropbox created we can transfer the material over to it.

Do you think it would be helpful to have a section specifically addressing the question of whether CO<sub>2</sub> is a pollutant like CO, NO<sub>x</sub>, SO<sub>x</sub>, PM, etc.? If you want to add topics or suggest changes please do, the earlier the better as we begin filling out the contents.

Cheers,

Ross

On Mon, Apr 14, 2025 at 2:12 PM Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:

This is an excellent start! Can we move forward by iterating with this document for now? Please feel free to add whatever material you like, and I can collate if there are any simultaneous changes. I will leave the substance to you all because I view my role as a facilitator rather than a contributor, but please let me know how I can be most helpful.

Steve is correct that this document should be clear and understandable for non-experts. My understanding is that it should also be sufficiently technical and comprehensive to inform policymakers on all relevant aspects of the science.

One area I can help with might be targeting your work for the very brief window we have open at the moment. I am including a few lines verbatim below from key documents to highlight the areas of inquiry that are most relevant to the policymaking process. Of course, you all should make your own judgments about what to include versus what to leave out.

Here is a key section of the Clean Air Act, 202(a)(1): "The Administrator shall by regulation prescribe (and from time to time revise) in accordance with the provisions of this section, standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare. Such standards shall be applicable to such vehicles and engines for their useful life (as determined under subsection (d), relating to useful life of vehicles for purposes of certification), whether such vehicles and engines are designed as complete systems or incorporate devices to prevent or control such pollution."

Section 202 can be found [here](#).

Here is another key section of the Clean Air Act, section 302(g): "The term 'air pollutant' means any air pollution agent or combination of such agents, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and byproduct

material) substance or matter which is emitted into or otherwise enters the ambient air. Such term includes any precursors to the formation of any air pollutant, to the extent the Administrator has identified such precursor or precursors for the particular purpose for which the term 'air pollutant' is used."

A threshold question raised in Justice Scalia's dissent in *Mass v. EPA* (which can be found [here](#)) is whether CO2 falls under the definition of an "air pollutant" under the Clean Air Act. The majority in *Mass v. EPA* found that *any* compound emitted into the ambient air fits the definition of "air pollutant," leading to a colorful footnote in the Scalia dissent ("It follows that everything airborne, from Frisbees to flatulence, qualifies as an 'air pollutant.' This reading of the statute defies common sense."). A scientific interpretation of this definition could be very helpful.

The next section in the statute is 302(h), which defines effects on welfare: "All language referring to effects on welfare includes, but is not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants." Positive impacts, including fertilization effects and beneficial warming, seem to be within scope here.

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As you all develop the draft, I encourage you to include as many citations to published materials as possible (links would work fine as placeholders). I have found this works better under a tight timeline than going back and looking for sources later. Please also feel free to task me with any research help you might need.

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So I've taken Ross' material, added some broader context, and cast it into the forcing/response/impact syllogism that most non-experts seem to get. The result is attached.

I think we can deal with the differences relative to 2009 in an appendix.

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[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)  
**Subject:** Re: Kickoff

Excellent list Ross. Wildfires are a significant topic to be addressed.

John C.

Sent from my iPhone

On Apr 11, 2025, at 4:05 PM, Ross McKittrick <[ross.mckitrick@gmail.com](mailto:ross.mckitrick@gmail.com)> wrote:

The attached represents my summary of the most questions needing to be answered, which I think this group is capable of answering in the next couple of weeks. Probably lots of material already in hand.

On Fri, Apr 11, 2025 at 4:24 PM Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:

Gentlemen,

I can't thank you enough for taking this on under such a tight timeline. Let's use this thread to exchange information, links, etc., and as we move forward, I'll see about a document-sharing platform and a shared document to work on simultaneously.

Best,



Travis

<DE.memo.outline.Apr.11.[RM].docx>

<Table.of.Contents.Apr14.docx>

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**To:** Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>  
**Cc:** Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>; [steven.koonin@gmail.com](mailto:steven.koonin@gmail.com);  
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<Table.of.Contents.Apr14.docx>

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**Attachments:** Table.of.Contents.Apr14.docx

Hi Travis

We developed the outline a bit further and assigned sections out yesterday. We'll keep you cc'd going forward.

Here is a Dropbox link that contains the current outline (also attached) which indicates who is working on each section

[https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyri8x/ANTU1qAQJ-zXCFzP\\_gsJcOs?rlkey=llz3qj9v46e1t5f4ywwxq7p8c&dl=0](https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyri8x/ANTU1qAQJ-zXCFzP_gsJcOs?rlkey=llz3qj9v46e1t5f4ywwxq7p8c&dl=0)

The link should give you all editing privileges.

I put folders in there for each of us. If the use of that Dropbox (which is on my own account) is acceptable for this project then we can share our work using it. Otherwise once we have an official Dropbox created we can transfer the material over to it.

Do you think it would be helpful to have a section specifically addressing the question of whether CO2 is a pollutant like CO, NOx, SOx, PM, etc.? If you want to add topics or suggest changes please do, the earlier the better as we begin filling out the contents.

Cheers,

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**CONFIDENTIAL**  
**FOR DISCUSSION PURPOSES ONLY**

**Current Scientific Understanding of US Greenhouse Gas Emissions from Motor  
Vehicles as an Endangerment to US Citizens**

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**Sent:** Monday, April 14, 2025 2:12 PM  
**To:** Steven Koonin  
**Cc:** John Christy; Ross McKittrick; roywspencer@hotmail.com  
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## **Discussion of:**

### **US Greenhouse Gas Emissions from Motor Vehicles as an Endangerment to US Citizens**

April 11, 2025

Supposing that we are writing this for a numerate non-scientist.

#### **Preliminaries**

- Climate is the long-term stats of weather. Typically 30 years. It involves averages, variations, extreme events. The weather any one year does not a climate make
- There are other components of the climate beyond the atmosphere – oceans are very important, ice, biosphere, solid earth
- The climate varies a lot on its own
  - From place to place
  - From time to time via internal dynamics,
- It also varies in response to external forcings
  - Natural forcings like Milankovitch
  - Anthropogenic forcings
- Humans are influencing the climate through anthropogenic GHGs
  - Mostly CO<sub>2</sub> from fossil fuels, but other GHGs as well
  - Time history of emissions, concentrations, aerosols, land use, forcings
- How will the climate system change in response to those forcings
  - Need to know:
    - Natural variability (how has climate changed in the past)
    - Current and future emissions
    - How will climate respond to growing human influences
  - It's difficult to know
    - Poor records in the past – the earth is big, the ocean largely unobserved
    - Unknown futures (future development, future technologies, ...)
    - The forcing (and hence response) is physically small – obscured by the noise and other forcings
    - It's a multicomponent nonlinear chaotic system that's difficult to model

#### **What has the climate been doing?**

- How are the major features of the climate measured (temperature, precipitation) and how reliable are the measurements? [JC, RS]
- Stats on US and global temp, precip, storms, ...



- What has the IPCC said about observed changes in extreme weather? SREX, AR4, AR5, AR6 survey [RM has compilation]
- What does the scientific literature say about trends in:
  - Heatwaves including the ability to adaptively respond [RM has some info on adaptation]
  - Average precipitation [RM and JC have written on this]
  - Extreme precipitation [RM and JC have written on this]
  - Tornadoes
  - Hurricanes
  - Wildfires
  - Other extreme weather categories

### **How will the climate respond**

- Is there evidence from outside climate models regarding the sensitivity of the climate to changes in GHG levels? [RM, RS, JC]
- Models – their construction, challenges, deficiencies
  - Can climate models faithfully and accurately reproduce climatic changes of the past century, or more recent intervals? [JC, RM]
  - What is the basis for attributing individual extreme weather events to changes in GHG's and how precise is this science? [RM]
  - What are various emissions scenarios and how is the climate projected to change under them

### **What will be the impact of that response on ecosystems and societies**

- Mortality risks from extreme heat and cold
- What does the scientific literature say about climate change impacts on agriculture, including CO<sub>2</sub> fertilization effects? [RM has info on this]
- What does the economics literature say about the effects of climate change on economic growth? [RM has info on this]
- What does the mainstream economics literature assert regarding the likely social costs of CO<sub>2</sub> emissions? [RM]
- What does the scientific and economic literature say about the ability of people and society to adapt over time to adverse weather conditions in such a way as to mitigate the danger?

### **Specialization to US transportation**

- US CO<sub>2</sub> emission volumes by sector
- US vehicle emissions as a fraction of global CO<sub>2</sub> emissions
- Estimated effect on global climate of variations in US tailpipe CO<sub>2</sub> emissions

### **Summary and conclusions**

- Conclusions as to whether US weather is materially more dangerous than in the past

- Conclusions as to whether GHGs have a well-understood in making the weather more dangerous
- Conclusions as to the role of US vehicle emissions in global climate change
- Final comments and conclusions

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<DE.memo.outline.Apr.11.[RM].docx>

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**CC:** steven.koonin@gmail.com; climateman60@gmail.com; roywspencer@hotmail.com  
**Subject:** Re: Kickoff  
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# **Discussion of: US Greenhouse Gas Emissions from Motor Vehicles as an Endangerment to US Citizens**

April 11, 2025

## **1. Clarification of questions**

- a. Not being questioned:
  - i. Is CO<sub>2</sub> an infrared-absorbing (“greenhouse”) gas? Yes
  - ii. Has warming relative to early 1800s been observed? Yes in some respects
  - iii. Does weather within its known range of natural variability sometimes pose danger to individuals and the public? Yes
- b. Questions being asked:
  - i. Is the weather materially more dangerous to the public today than, say, 50 or 100 years ago?
  - ii. If so, do GHGs have a well-understood role in making the weather more dangerous?
  - iii. If so, are US vehicle emissions of CO<sub>2</sub> a sufficient quantum to be dangerous in and of themselves?

## **2. Is the weather materially more dangerous to the public than, say, 50 or 100 years ago?**

- a. What has the IPCC said about observed changes in extreme weather? SREX, AR4, AR5, AR6 survey [RM has compilation]
- b. What does the scientific literature say about trends in:
  - i. Heatwaves including the ability to adaptively respond [RM has some info on adaptation]
  - ii. Average precipitation [RM and JC have written on this]
  - iii. Extreme precipitation [RM and JC have written on this]
  - iv. Tornadoes
  - v. Hurricanes
  - vi. Mortality risks from extreme heat and cold
  - vii. Other extreme weather categories
- c. What does the scientific literature say about climate change impacts on agriculture, including CO<sub>2</sub> fertilization effects? [RM has info on this]
- d. What does the economics literature say about the effects of climate change on economic growth? [RM has info on this]
- e. What does the scientific and economic literature say about the ability of people and society to adapt over time to adverse weather conditions in such a way as to mitigate the danger?
- f. Conclusions

## **3. If so, do GHGs have a well-understood role in making the weather more dangerous?**

- a. What does the IPCC say about the attributable role of GHGs in extreme weather? [RS has info on this]
- b. What is the basis for attributing climate change in general to anthropogenic causes, and how precise is this science? (fingerprinting methodology) [RM has info on this]
- c. How are climate models constructed and tested? [SK and RS have info]

- d. How are the major features of the climate measured (temperature, precipitation) and how reliable are the measurements? [JC, RS]
  - e. Can climate models faithfully and accurately reproduce climatic changes of the past century, or more recent intervals? [JC, RM]
  - f. Is there evidence from outside climate models regarding the sensitivity of the climate to changes in GHG levels? [RM, RS, JC]
  - g. How reliable is the basis for model projections of future climate changes?
  - h. What does the mainstream economics literature assert regarding the likely social costs of CO<sub>2</sub> emissions? [RM]
  - i. What is the basis for attributing individual extreme weather events to changes in GHG's and how precise is this science? [RM]
  - j. Conclusions
- 4. If so, are US vehicle emissions of CO<sub>2</sub> a sufficient quantum to be dangerous in and of themselves?**
- a. US CO<sub>2</sub> emission volumes by sector
  - b. US vehicle emissions as a fraction of global CO<sub>2</sub> emissions
  - c. Estimated effect on global climate of variations in US tailpipe CO<sub>2</sub> emissions
  - d. Conclusions
- 5. What evidence was provided in the 2009 TSD and to what extent is it still relevant?**
- 6. Summary and conclusions**
- a. Conclusions as to whether US weather is materially more dangerous than in the past
  - b. Conclusions as to whether GHGs have a well-understood in making the weather more dangerous
  - c. Conclusions as to the role of US vehicle emissions in global climate change
  - d. Final comments and conclusions

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**Sent:** Friday, April 18, 2025 1:38 PM  
**To:** Roy Spencer  
**Cc:** Travis Fisher; Steven Koonin; John Christy  
**Subject:** Re: Section 1.4.3 attached

I agree the 2 sections work well together, and provide a segue to the later section on greening. I've worked in some material I modified from previous projects and uploaded it to the Dropbox. I added in summary bullet points.  
Ross

On Fri, Apr 18, 2025 at 7:34 AM Roy Spencer <roywspencer@hotmail.com> wrote:  
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I think we should combine sections 1.4.3 and 1.4.4 (attached) which I now call "The carbon cycle, emissions scenarios, and global greening".

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-Roy

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In addition to the uncertain sensitivity of the climate system to increasing CO<sub>2</sub>, future climate projections also depend upon uncertain estimates of how much “extra” CO<sub>2</sub> will accumulate in the atmosphere in the future. These uncertain estimates are a function of two components: (1) future rates of global anthropogenic CO<sub>2</sub> emissions, and (2) how fast the land and ocean remove extra CO<sub>2</sub> from the atmosphere.

Global carbon cycle models are used to quantify the second component, using estimates of various land and ocean processes that remove CO<sub>2</sub> from, and emit CO<sub>2</sub> into, the atmosphere. Our understanding of these processes was reviewed by Crisp et al. (2021). The natural fluxes of CO<sub>2</sub> in and out of the Earth’s surface are very large, many times anthropogenic emissions, but those CO<sub>2</sub> sources and sinks were assumed to be in approximate balance in pre-Industrial times, as evidenced by relatively constant levels of atmospheric CO<sub>2</sub> in centuries past derived from air bubbles in ice cores. This is one of the reasons why increasing atmospheric CO<sub>2</sub> levels are believed to be dominated by anthropogenic sources.

Specifically, fossil fuel burning (and to a lesser extent land use [biomass burning] and cement production) has led to steadily increasing CO<sub>2</sub> levels in the atmosphere, as shown in Fig. X1.

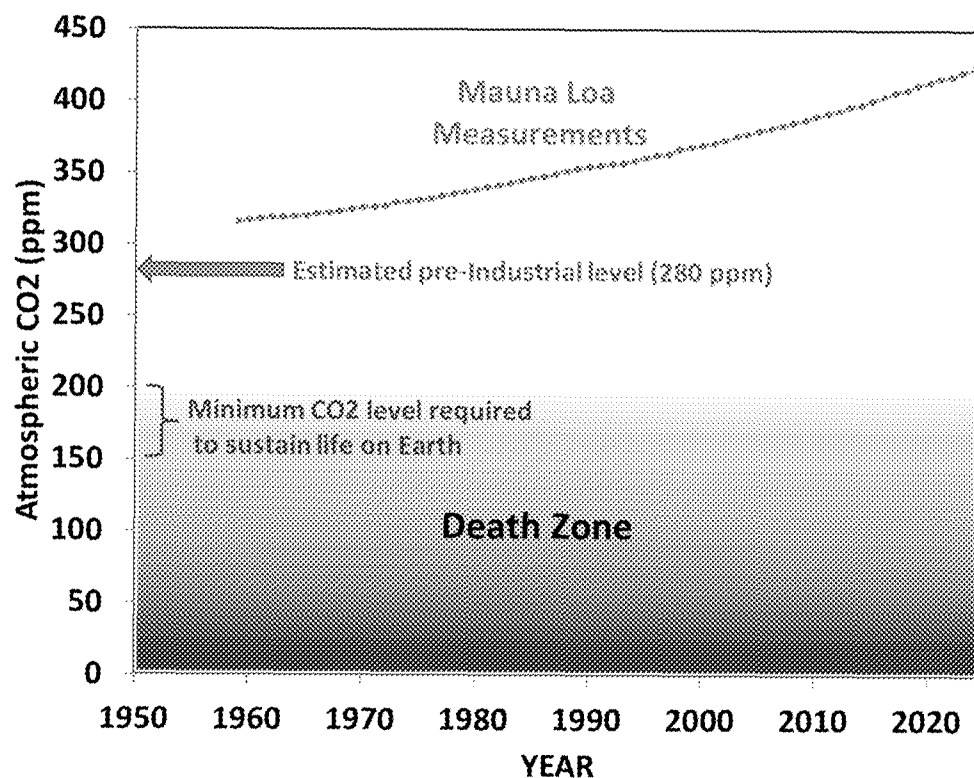


Fig. X1. Yearly average atmospheric CO<sub>2</sub> concentrations (1959-2024) measured at Mauna Loa, HI (green) compared to the estimated pre-Industrial CO<sub>2</sub> concentration of 280 ppm, and the estimated minimum levels required to sustain life on Earth (150 to 200 ppm).

As noted in Fig. X1, life on Earth requires CO<sub>2</sub> levels of at least 150 to 200 ppm. This is because the food chains on land and in the ocean begin with vegetation and biota that depend upon photosynthesis, which requires CO<sub>2</sub>.



Life on Earth has benefitted from more CO<sub>2</sub> in the atmosphere. Since routine monitoring of atmospheric CO<sub>2</sub> levels began in 1958 at Mauna Loa, Hawaii, it has been calculated that each year natural processes remove a net amount of CO<sub>2</sub> equivalent to about 50% of global emissions. Thus, anthropogenic CO<sub>2</sub> emissions average twice what is required to explain the atmospheric rise in CO<sub>2</sub> concentration. The near-constancy of that 50% fraction also means that the more CO<sub>2</sub> humanity produces, the faster Nature removes CO<sub>2</sub> from the atmosphere. That 50% fraction changes somewhat from year to year due to natural carbon cycle imbalances from El Nino, La Nina, and varying weather patterns. There was also a substantial additional reduction in atmospheric CO<sub>2</sub> after the 1991 eruption of Mt. Pinatubo, a curious result that has yet to be explained (Angert et al., 2004).

Another consequence of the rapid rate of removal of CO<sub>2</sub> from the atmosphere is that “Net Zero” emissions are not required to halt the rise in atmospheric CO<sub>2</sub>. If global emissions were to suddenly be reduced by 50%, the natural rate of CO<sub>2</sub> removal would approximately match anthropogenic emissions, and CO<sub>2</sub> levels would stop rising.

The main processes which remove excess CO<sub>2</sub> from the atmosphere are increased production of land vegetation (especially at high latitudes), some increase in the sequestering of carbon in soils, and uptake of CO<sub>2</sub> by the ocean due to the increasing partial pressure of atmospheric CO<sub>2</sub> over that of CO<sub>2</sub> dissolved in the ocean. All twenty land carbon cycle models tracked by the Global Carbon Project (Friedlingstein et al., 2024) show land processes have been removing excess CO<sub>2</sub> at an increasing rate since 1959. This is consistent with a “global greening” phenomenon observed by satellites since monitoring of global greenness began in the 1982. This greening has been traced to CO<sub>2</sub> fertilization and greater drought tolerance of plants exposed to elevated CO<sub>2</sub> levels. While there had been some uncertainty whether a greening trend continued beyond 2000, the most recent research (Chen et al., 2023) has shown continued greening, with even some slight acceleration since 2000.

While land vegetation has been responding positively to more atmospheric CO<sub>2</sub>, uptake of extra CO<sub>2</sub> by ocean biological processes remains too uncertain to be reliably measured. Our current understanding of these and many more carbon cycle processes was reviewed by Crisp et al. (2021).

When the two components required to estimate future atmospheric CO<sub>2</sub> concentrations are combined (anthropogenic emissions estimates along with carbon cycle model estimates of atmospheric CO<sub>2</sub> removal), we get estimates of future CO<sub>2</sub> concentrations required by climate models to estimate future rates of warming. Because the largest uncertainty lies in future global rate of anthropogenic CO<sub>2</sub> emissions, the IPCC has used a wide variety of possible emissions scenarios, and the four most common ones from the CMIP6 climate model experiments are shown in Fig. X2.

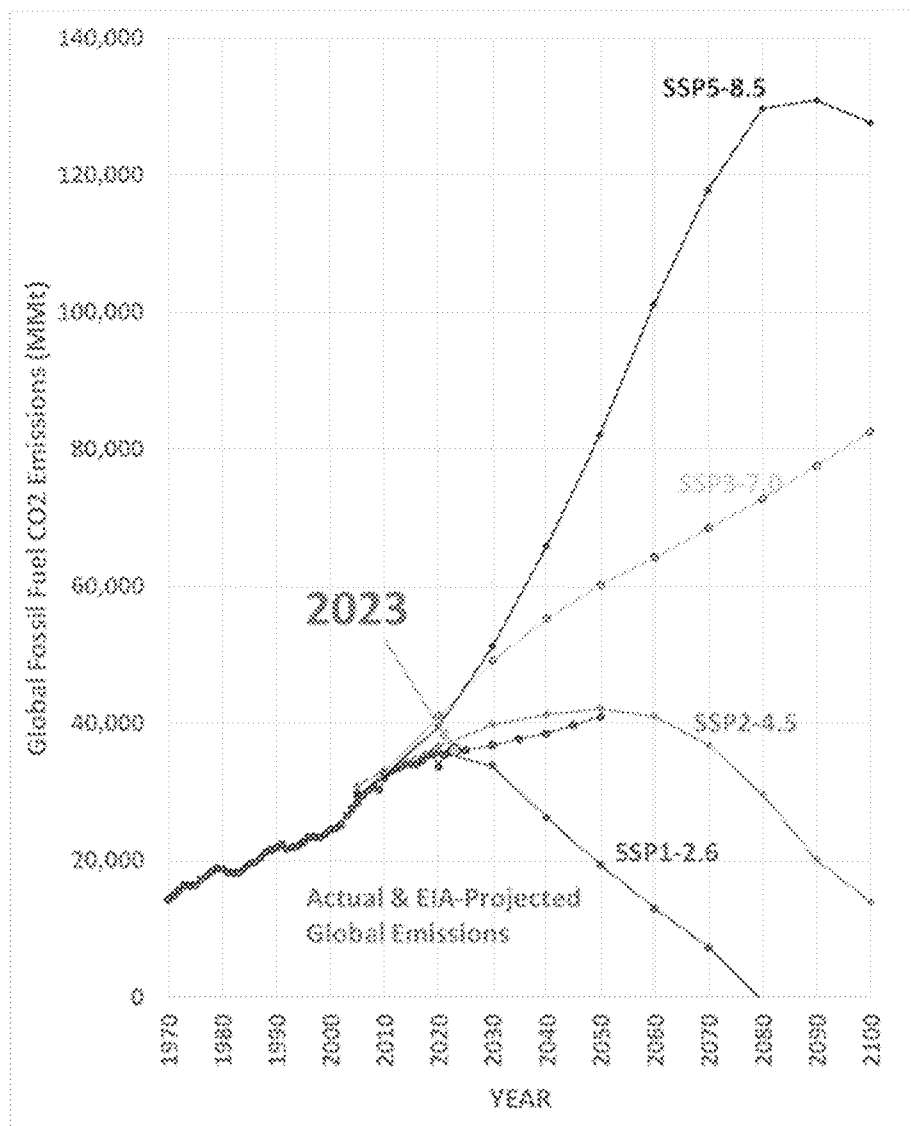


Fig. X2. The Shared Socioeconomic Pathway (SSP) scenarios of future atmospheric CO<sub>2</sub> concentrations used by the IPCC in their CMIP6 climate model projections, compared to actual global emissions (up to 2023) and EIA-projected emissions, 2025-2050 (green).

Also shown in Fig. X2 are the yearly estimates of past global CO<sub>2</sub> emissions (green) along with Energy Information Administration (EIA) future estimates based upon projections in global energy use every five years until 2050.

Importantly, as of 2023 global CO<sub>2</sub> emissions have been tracking *well below* the two highest emissions scenarios used by the IPCC (SSP5-8.5 and SSP3-7.0). This is significant because most of the climate model projections relied upon for energy policy decisions have been from these two emissions scenarios (or similar scenarios), which are now increasingly considered unrealistic (e.g. Ritchie and Dowlatabadi, 2017; Pielke & Ritchie, 2017; Pielke & Ritchie, 2021).

Yet, despite these unrealistically high CO2 concentrations, extreme climate projections are still widely used by the IPCC, environmental groups, and in reports (e.g. the Fifth U.S. National Climate Assessment, NCA5) to warn of the dangers of climate change. In other words, the public and policymakers are being misled by climate model projections showing *what could theoretically happen if CO2 emissions increase drastically, even though recent trends indicate that will not happen*. This is one more reason why current climate model projections, and especially assessments which only highlight unrealistic future emissions scenarios, should not be relied upon for energy policy decisions.

As shown above, there is also increasing evidence for benefits to life on Earth from more CO2 in the atmosphere.

---

**From:** John Christy <climateman60@gmail.com>  
**Sent:** Monday, April 28, 2025 9:40 PM  
**To:** Steve Koonin  
**Cc:** Travis Fisher; Judith Curry; Ross McKittrick; Roy Spencer  
**Subject:** Re: NYT on NCA

Steve

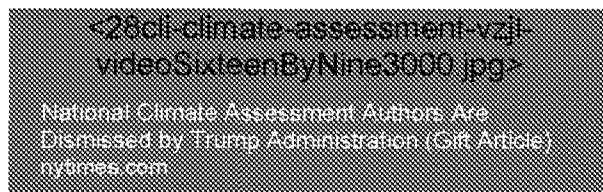
This reminds me of the day President Biden fired all of us on the EPAs Scientific Advisory Board (while we were in the midst of writing projects) and replaced with environmental activists.

I think it is interesting that these current authors feel as if they are entitled to be the only ones to have the last word on climate. We saw what has happened with the previous NCAs.

John C.

John Christy  
Director, Earth System Science Center  
Professor, Atmos and Earth Science  
Alabama State Climatologist  
The University of Alabama in Huntsville  
climateman60@gmail.com

On Apr 28, 2025, at 8:23 PM, Steven Koonin <steven.koonin@gmail.com> wrote:



Steven E. Koonin

...

---

**From:** Steven Koonin [steven.koonin@gmail.com]  
**Sent:** 4/29/2025 1:23:44 AM  
**To:** John Christy [climatemanager60@gmail.com]  
**CC:** Travis Fisher [travis.scott.fisher@gmail.com]; Judith Curry [curry.judith@gmail.com]; Ross McKittrick [ross.mckittrick@gmail.com]; Roy Spencer [roywspencer@hotmail.com]  
**Subject:** NYT on NCA



National Climate Assessment Authors Are  
Dismissed by Trump Administration (Gift Article)  
nytimes.com

Steven E. Koonin

.....

---

**From:** John Christy <climateman60@gmail.com>  
**Sent:** Saturday, April 19, 2025 12:11 PM  
**To:** Judith Curry  
**Cc:** Ross McKittrick; Travis Fisher; Roy Spencer; Steve Koonin  
**Subject:** Re: Section 2.1  
**Attachments:** Untitled attachment.htm; [2.1.2]Apr19.[JRC].docx; Untitled attachment.htm

Judy

Here is what I had written on 2.1.2. I can't seem to place files in my dropbox folder, even when logged in. I guess it doesn't recognize me as legitimate.

Note: From now on I will use initials JRC to distinguish from Judy's JC.

John C.

John Christy  
Director, Earth System Science Center  
Professor, Atmos and Earth Science  
Alabama State Climatologist  
The University of Alabama in Huntsville  
climateman60@gmail.com

[img alt="broken image icon" data-bbox="54 477 77 490"/>

> On Apr 19, 2025, at 10:44 AM, Judith Curry <curry.judith@gmail.com> wrote:

>

> See attached text for 2.1. I've changed the content for this section, to socioeconomic context for trend in "dangerous", and this includes brief description of how improved weather forecasting is saving lives and \$\$.

> I think this is more relevant than a description of advances in forecasting extreme weather, let me know what think. If you are ok with this i will add to drop box

>

>

> On Sat, Apr 19, 2025 at 7:28 AM Ross McKittrick <ross.mckittrick@gmail.com <<mailto:ross.mckittrick@gmail.com>>> wrote:

>> I also have some text on mortality impacts. Also I can add a bit to the vector-borne topic from my work on malaria a few years ago.

>> Sections 4.2 and 4.3 could easily be combined and build from what John already wrote.

>> Ross

>>

>>

>> On Sat, Apr 19, 2025 at 8:28 AM Judith Curry <curry.judith@gmail.com <<mailto:curry.judith@gmail.com>>> wrote:

>>> I can do 9 am (6 am PDT) for a call,

>>>

>>> On Fri, Apr 18, 2025 at 7:57 PM Ross McKittrick <ross.mckittrick@gmail.com <<mailto:ross.mckittrick@gmail.com>>> wrote:

>>>> I'm thinking that a conference call or zoom meeting would be helpful so we can get caught up on the work done up to now and also the administrative side of things. Everything seems to be moving at a rapid pace. Could we schedule it for Monday morning at 9 ET?

>>>> Ross

>>>>

>>>>

>>>> On Fri, Apr 18, 2025 at 10:03 PM Travis Fisher <travis.scott.fisher@gmail.com <<mailto:travis.scott.fisher@gmail.com>>> wrote:

>>>>> Thanks so much, Judy!

>>>>>

>>>>> Great questions. I don't think anyone has taken on the "air pollutant" issue. Please feel free to tackle it if you like!

>>>>>

>>>>> Regarding the regulation in question, I've been told this summary of the science will be published as a technical support document relevant to a new proposed rule on tailpipe emissions standards for motor vehicles. I don't know whether that means all motor vehicles or just light- and medium-duty vehicles. It might be helpful to differentiate GHG emissions from the different classes to give the EPA flexibility in that regard.

>>>>>

>>>>> The previous administration combined the rules for GHGs and criteria pollutants into a "multi-pollutant <<https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-multi-pollutant-emissions-standards-model>>" rule, and I don't have any information on how this administration will package the different emissions standards. The exact charge for you all is to provide an update on the science relevant to the EPA's endangerment determination with respect to GHGs. As I understand the assignment, the scope is only GHGs, not criteria pollutants.

>>>>>

>>>>> Keep the questions coming! I can run them up the chain if I don't know the answers, and I am happy to relay any questions you all have to the relevant folks at DOE or other agencies.

>>>>>

>>>>> For your awareness, I was asked to share the table of contents with the EPA team this evening, which I did (the April 18 version), with the understanding that it is a one-way street (me informing them of your work so they know what's coming, not them sending feedback or micro-managing it). As I assured Steve in the early stages of this work, scientific integrity is paramount, and I will do everything in my power to preserve every word of the document as you all write it. In fact, the EPA team asked that the document be DOE-branded, meaning our true audience is the Secretary of Energy, and he emphasized to me that he wants nothing but science. In other words, the only compromise you have to make in how this is written is among yourselves, not between you all and policymakers, lawyers, or economists.

>>>>>

>>>>> Thanks again for lending your expertise to this effort, all of you.

>>>>>

>>>>> Best,

>>>>> Travis

>>>>>

>>>>>

>>>>> On Fri, Apr 18, 2025 at 8:46 PM Judith Curry <[curry.judith@gmail.com](mailto:curry.judith@gmail.com) <<mailto:curry.judith@gmail.com>>> wrote:

>>>>>> I have a lot of material already written that should be relevant. I have a draft of the sea level rise section completed, am sending this to my assistant to format, will upload monday.

>>>>>>

>>>>>> Roy, let me know if there are sections you can't complete, i may have some text that is already written

>>>>>>

>>>>>> On Fri, Apr 18, 2025 at 3:06 PM Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com) <<mailto:travis.scott.fisher@gmail.com>>> wrote:

>>>>>>> Good afternoon,

>>>>>>>

>>>>>>> I'm happy to report that I just talked with Judy, and she accepted the mission (in case you're wondering, the vetting issue was a mishap). This is great news because the Secretary wanted all of you to be able to contribute.

>>>>>>>

>>>>>>> Let's make sure to include Judy in all of our correspondence from now on. The documents should be available here:

>>>>>>> [https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyrr8x/ANTU1qAQJ-zXCFzP\\_gsJcOs?rlkey=11z3qj9v46e1t5f4ywwxq7p8c&e=1&dl=0](https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyrr8x/ANTU1qAQJ-zXCFzP_gsJcOs?rlkey=11z3qj9v46e1t5f4ywwxq7p8c&e=1&dl=0). Please let us know if you don't have access.

>>>>>>>

>>>>>>> Best,

>>>>>>> Travis

>>>>>>>

>>>>>>>

>>>>>>> On Fri, Apr 18, 2025 at 4:59 PM Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com) <<mailto:ross.mckittrick@gmail.com>>> wrote:

>>>>>>>> Thanks John. The quote from Mauritsen and Roeckner is a great addition.

>>>>>>>> I find the figure hard to follow, whereas the quote makes the point very clearly, in their own words.

>>>>>>>>

>>>>>>>>

>>>>>>>> On Fri, Apr 18, 2025 at 4:55 PM John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com) <<mailto:climateman60@gmail.com>>> wrote:

>>>>>>>>> Ross

>>>>>>>>>

>>>>>>>> I've never been successful with dropbox and my record is still intact.  
>>>>>>>>  
>>>>>>>> Attached is 1.6.2 to which I added a paragraph.  
>>>>>>>>  
>>>>>>>> Also attached is a chart I annotated from AR6. I think this story demonstrates modelers are just playing with tuning parameters. Is there some way to use this information here (not necessarily in this format)?  
>>>>>>>>  
>>>>>>>> John C.  
>>>>>>>>  
>>>>>>>> <Fig\_AR6\_3.8\_Apr18[JC].png>  
>>>>>>>>  
>>>>>>>> On Fri, Apr 18, 2025 at 3:32 PM Ross McKittrick <ross.mckittrick@gmail.com <<mailto:ross.mckittrick@gmail.com>>>  
wrote:  
>>>>>>>> I've uploaded a new version of Section 2.2 to your folder. It includes the earlier material quoting all the relevant IPCC and NCA17 stuff and adds some external source information I found. Still needs a brief summary. Others may have more to add.  
>>>>>>>>  
>>>>>>>>  
>>>>>>>> On Fri, Apr 18, 2025 at 3:05 PM Roy Spencer <roywspencer@hotmail.com <<mailto:roywspencer@hotmail.com>>>  
wrote:  
>>>>>>>> Ross:  
>>>>>>>> Let me look early in the morning to see which ones I feel like I can knock out the fastest. Our "guidance" has been to start from "scratch", while relying on preexisting materials where it helps. I think I know why we've been told this, but it's not my place to say.  
>>>>>>>> - Roy  
>>>>>>>>  
>>>>>>>>  
>>>>>>>> Sent from my Verizon, Samsung Galaxy smartphone  
>>>>>>>>  
>>>>>>>>  
>>>>>>>> ----- Original message -----  
>>>>>>>> From: Ross McKittrick <ross.mckittrick@gmail.com <<mailto:ross.mckittrick@gmail.com>>>  
>>>>>>>> Date: 4/18/25 10:49 AM (GMT-06:00)  
>>>>>>>> To: Roy Spencer <roywspencer@hotmail.com <<mailto:roywspencer@hotmail.com>>>  
>>>>>>>> Cc: Travis Fisher <travis.scott.fisher@gmail.com <<mailto:travis.scott.fisher@gmail.com>>>, Steven Koonin <steven.koonin@gmail.com <<mailto:steven.koonin@gmail.com>>>, John Christy <climateman60@gmail.com <<mailto:climateman60@gmail.com>>>  
>>>>>>>> Subject: Re: I'll need help: 10 sections to go  
>>>>>>>>  
>>>>>>>> Sorry Roy, I didn't mean to swamp you, I figured those were sections you already had in the can from previous work. Looking through my own folders I have some material I forgot I had written which I can repurpose. Can you send a list of the sections you are able to do, and the ones you would like to hand off for the time being?  
>>>>>>>>  
>>>>>>>> Also to Travis' point we should look to having Judy help some of the sections. Travis, she can be reached via [curry.judith@gmail.com](mailto:curry.judith@gmail.com) <<mailto:curry.judith@gmail.com>>  
>>>>>>>>  
>>>>>>>> Ross  
>>>>>>>>  
>>>>>>>>  
>>>>>>>> On Fri, Apr 18, 2025 at 7:40 AM Roy Spencer <roywspencer@hotmail.com <<mailto:roywspencer@hotmail.com>>>  
wrote:  
>>>>>>>> All:  
>>>>>>>>  
>>>>>>>> I don't see how I'm going to do the 10 more sections assigned to me (1.6.1 onward) in the time remaining. Feel free to jump in.  
>>>>>>>>  
>>>>>>>> -Roy  
>>>>>>>>  
>>>>>>>> From: Roy Spencer <roywspencer@hotmail.com <<mailto:roywspencer@hotmail.com>>>



>>>>>>>>>> Sent: Friday, April 18, 2025 6:34 AM  
>>>>>>>>>> To: Ross McKittrick <ross.mckittrick@gmail.com <<mailto:ross.mckittrick@gmail.com>>>; Travis Fisher  
<travis.scott.fisher@gmail.com <<mailto:travis.scott.fisher@gmail.com>>>  
>>>>>>>>>> Cc: Steven Koonin <steven.koonin@gmail.com <<mailto:steven.koonin@gmail.com>>>; John Christy  
<climateman60@gmail.com <<mailto:climateman60@gmail.com>>>  
>>>>>>>>>> Subject: Section 1.4.3 attached  
>>>>>>>>>>  
>>>>>>>>>> Ross:  
>>>>>>>>>>  
>>>>>>>>>> I think we should combine sections 1.4.3 and 1.4.4 (attached) which I now call "The carbon cycle, emissions  
scenarios, and global greening".  
>>>>>>>>>>  
>>>>>>>>>> I found that all of these need to be discussed together. Feel free to reword the section title.  
>>>>>>>>>>  
>>>>>>>>>> -Roy  
>>>>>>>>>>  
>>>>>>>>>> From: Roy Spencer <roywspencer@hotmail.com <<mailto:roywspencer@hotmail.com>>>  
>>>>>>>>>> Sent: Thursday, April 17, 2025 6:17 AM  
>>>>>>>>>> To: Ross McKittrick <ross.mckittrick@gmail.com <<mailto:ross.mckittrick@gmail.com>>>; Travis Fisher  
<travis.scott.fisher@gmail.com <<mailto:travis.scott.fisher@gmail.com>>>  
>>>>>>>>>> Cc: Steven Koonin <steven.koonin@gmail.com <<mailto:steven.koonin@gmail.com>>>; John Christy  
<climateman60@gmail.com <<mailto:climateman60@gmail.com>>>  
>>>>>>>>>> Subject: Section 1.4.2 Can climate models reproduce the recent past?  
>>>>>>>>>>  
>>>>>>>>>> Attached. This is the minimum I think needs to be in this section. Of course, more could be added, but I think we  
need to stick to our strongest arguments, given the limited time available.  
>>>>>>>>>>  
>>>>>>>>>> -Roy  
>>>>>>>>>> From: Roy Spencer <roywspencer@hotmail.com <<mailto:roywspencer@hotmail.com>>>  
>>>>>>>>>> Sent: Wednesday, April 16, 2025 7:16 AM  
>>>>>>>>>> To: Ross McKittrick <ross.mckittrick@gmail.com <<mailto:ross.mckittrick@gmail.com>>>; Travis Fisher  
<travis.scott.fisher@gmail.com <<mailto:travis.scott.fisher@gmail.com>>>  
>>>>>>>>>> Cc: Steven Koonin <steven.koonin@gmail.com <<mailto:steven.koonin@gmail.com>>>; John Christy  
<climateman60@gmail.com <<mailto:climateman60@gmail.com>>>  
>>>>>>>>>> Subject: Some Spencer inputs  
>>>>>>>>>>  
>>>>>>>>>> I took it upon myself to write a preamble in Section 1.3 Drivers of climate change (attached), which seemed  
necessary to introduce some basic concepts.  
>>>>>>>>>>  
>>>>>>>>>> Also attached are my initial submissions for 1.3.2 and 1.3.3.  
>>>>>>>>>>  
>>>>>>>>>> NO references added yet.  
>>>>>>>>>>  
>>>>>>>>>> One of the things I believe we need to watch out for is neglecting to come to conclusions along the way... There is a  
tendency to get mired in the technical details without getting around to saying what each section might mean in eventual policy  
decisions related to the Endangerment Finding. In my experience, it is not possible to dumb-down this stuff too much. I suggest some  
sort of "Summary Boxes" with 1-2 simplified statements highlighting a main conclusion of each section that would have policy  
relevance.  
>>>>>>>>>>  
>>>>>>>>>> -Roy  
>>>>>>>>>> From: Ross McKittrick <ross.mckittrick@gmail.com <<mailto:ross.mckittrick@gmail.com>>>  
>>>>>>>>>> Sent: Monday, April 14, 2025 1:37 PM  
>>>>>>>>>> To: Travis Fisher <travis.scott.fisher@gmail.com <<mailto:travis.scott.fisher@gmail.com>>>  
>>>>>>>>>> Cc: Steven Koonin <steven.koonin@gmail.com <<mailto:steven.koonin@gmail.com>>>; John Christy  
<climateman60@gmail.com <<mailto:climateman60@gmail.com>>>; roywspencer@hotmail.com <<mailto:roywspencer@hotmail.com>>>  
<roywspencer@hotmail.com <<mailto:roywspencer@hotmail.com>>>  
>>>>>>>>>> Subject: Re: Kickoff  
>>>>>>>>>>  
>>>>>>>>>> Hi Travis  
>>>>>>>>>> We developed the outline a bit further and assigned sections out yesterday. We'll keep you cc'd going forward.  
>>>>>>>>>>

>>>>>>>>>> Here is a Dropbox link that contains the current outline (also attached) which indicates who is working on each section

>>>>>>>>>>

>>>>>>>>>> [https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyri8x/ANTU1qAQJ-zXCFzP\\_gsJcOs?rlkey=11z3qj9v46e1t5f4ywwxq7p8c&dl=0](https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyri8x/ANTU1qAQJ-zXCFzP_gsJcOs?rlkey=11z3qj9v46e1t5f4ywwxq7p8c&dl=0)

>>>>>>>>>> The link should give you all editing privileges.

>>>>>>>>>>

>>>>>>>>>> I put folders in there for each of us. If the use of that Dropbox (which is on my own account) is acceptable for this project then we can share our work using it. Otherwise once we have an official Dropbox created we can transfer the material over to it.

>>>>>>>>>>

>>>>>>>>>> Do you think it would be helpful to have a section specifically addressing the question of whether CO2 is a pollutant like CO, NOx, SOx, PM, etc.? If you want to add topics or suggest changes please do, the earlier the better as we begin filling out the contents.

>>>>>>>>>> Cheers,

>>>>>>>>>> Ross

>>>>>>>>>>

>>>>>>>>>> On Mon, Apr 14, 2025 at 2:12 PM Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:

>>>>>>>>>> This is an excellent start! Can we move forward by iterating with this document for now? Please feel free to add whatever material you like, and I can collate if there are any simultaneous changes. I will leave the substance to you all because I view my role as a facilitator rather than a contributor, but please let me know how I can be most helpful.

>>>>>>>>>>

>>>>>>>>>> Steve is correct that this document should be clear and understandable for non-experts. My understanding is that it should also be sufficiently technical and comprehensive to inform policymakers on all relevant aspects of the science.

>>>>>>>>>>

>>>>>>>>>> One area I can help with might be targeting your work for the very brief window we have open at the moment. I am including a few lines verbatim below from key documents to highlight the areas of inquiry that are most relevant to the policymaking process. Of course, you all should make your own judgments about what to include versus what to leave out.

>>>>>>>>>>

>>>>>>>>>> Here is a key section of the Clean Air Act, 202(a)(1): "The Administrator shall by regulation prescribe (and from time to time revise) in accordance with the provisions of this section, standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare. Such standards shall be applicable to such vehicles and engines for their useful life (as determined under subsection (d), relating to useful life of vehicles for purposes of certification), whether such vehicles and engines are designed as complete systems or incorporate devices to prevent or control such pollution."

>>>>>>>>>>

>>>>>>>>>> Section 202 can be found here <<https://www.law.cornell.edu/uscode/text/42/7521>>.

>>>>>>>>>>

>>>>>>>>>> Here is another key section of the Clean Air Act, section 302(g): "The term 'air pollutant' means any air pollution agent or combination of such agents, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and byproduct material) substance or matter which is emitted into or otherwise enters the ambient air. Such term includes any precursors to the formation of any air pollutant, to the extent the Administrator has identified such precursor or precursors for the particular purpose for which the term 'air pollutant' is used."

>>>>>>>>>>

>>>>>>>>>> A threshold question raised in Justice Scalia's dissent in *Mass v. EPA* (which can be found here <<https://supreme.justia.com/cases/federal/us/549/497/>>) is whether CO2 falls under the definition of an "air pollutant" under the Clean Air Act. The majority in *Mass v. EPA* found that any compound emitted into the ambient air fits the definition of "air pollutant," leading to a colorful footnote in the Scalia dissent ("It follows that everything airborne, from Frisbees to flatulence, qualifies as an 'air pollutant.' This reading of the statute defies common sense."). A scientific interpretation of this definition could be very helpful.

>>>>>>>>>>

>>>>>>>>>> The next section in the statute is 302(h), which defines effects on welfare: "All language referring to effects on welfare includes, but is not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants." Positive impacts, including fertilization effects and beneficial warming, seem to be within scope here.

>>>>>>>>>>

>>>>>>>>>> Section 302 can be found here <<https://www.law.cornell.edu/uscode/text/42/7602>>.

>>>>>>>>>>

>>>>>>>>>> As you all develop the draft, I encourage you to include as many citations to published materials as possible (links

would work fine as placeholders). I have found this works better under a tight timeline than going back and looking for sources later. Please also feel free to task me with any research help you might need.

>>>>>>>>>>

>>>>>>>>>> Best,

>>>>>>>>>> Travis

>>>>>>>>>>

>>>>>>>>>>

>>>>>>>>>>

>>>>>>>>>> On Fri, Apr 11, 2025 at 8:10 PM Steven Koonin <steven.koonin@gmail.com <<mailto:steven.koonin@gmail.com>>>> wrote:

>>>>>>>>>> I assume we're writing for non-experts. If so, some educating beyond the root questions is in order (it always helps if people feel smarter after reading).

>>>>>>>>>>

>>>>>>>>>> So I've taken Ross' material, added some broader context, and cast it into the forcing/response/impact syllogism that most non-experts seem to get. The result is attached.

>>>>>>>>>>

>>>>>>>>>> I think we can deal with the differences relative to 2009 in an appendix.

>>>>>>>>>>

>>>>>>>>>> SEK

>>>>>>>>>>

>>>>>>>>>> From: John Christy <climateman60@gmail.com <<mailto:climateman60@gmail.com>>>>

>>>>>>>>>> Sent: Friday, April 11, 2025 6:34 PM

>>>>>>>>>> To: Ross McKittrick <ross.mckittrick@gmail.com <<mailto:ross.mckittrick@gmail.com>>>>

>>>>>>>>>> Cc: Travis Fisher <travis.scott.fisher@gmail.com <<mailto:travis.scott.fisher@gmail.com>>>>;  
steven.koonin@gmail.com <<mailto:steven.koonin@gmail.com>>; roywspencer@hotmail.com <<mailto:roywspencer@hotmail.com>>

>>>>>>>>>> Subject: Re: Kickoff

>>>>>>>>>>

>>>>>>>>>> Excellent list Ross. Wildfires are a significant topic to be addressed.

>>>>>>>>>>

>>>>>>>>>> John C.

>>>>>>>>>>

>>>>>>>>>> Sent from my iPhone

>>>>>>>>>>

>>>>>>>>>>

>>>>>>>>>> On Apr 11, 2025, at 4:05 PM, Ross McKittrick <ross.mckittrick@gmail.com <<mailto:ross.mckittrick@gmail.com>>>> wrote:

>>>>>>>>>>

>>>>>>>>>>

>>>>>>>>>> The attached represents my summary of the most questions needing to be answered, which I think this group is capable of answering in the next couple of weeks. Probably lots of material already in hand.

>>>>>>>>>>

>>>>>>>>>>

>>>>>>>>>> On Fri, Apr 11, 2025 at 4:24 PM Travis Fisher <travis.scott.fisher@gmail.com <<mailto:travis.scott.fisher@gmail.com>>>> wrote:

>>>>>>>>>> Gentlemen,

>>>>>>>>>>

>>>>>>>>>> I can't thank you enough for taking this on under such a tight timeline. Let's use this thread to exchange information, links, etc., and as we move forward, I'll see about a document-sharing platform and a shared document to work on simultaneously.

>>>>>>>>>>

>>>>>>>>>> Best,

>>>>>>>>>> Travis

>>>>>>>>>>

>>>>>>>>>> <DE.memo.outline.Apr.11.[RM].docx>

>>>>>>>>>>

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>>>>>>>>>> Judith Curry, President

>>>>>>>>>> CFAN - Climate Forecast Applications Network

>>>>>>>>>> Reno, NV USA

>>>>>>>>>> curry.judith@cfanclimate.com <<mailto:curry.judith@gmail.com>> | +1.404.803.2012

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> <http://www.cfanclimate.n> <<http://www.cfanclimate.com/>>et  
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> <Dangerous DOE 2.docx>

Judy

Here is what I had written on 2.1.2. I can't seem to place files in my dropbox folder, even when logged in. I guess it doesn't recognize me as legitimate.

Note: From now on I will use initials JRC to distinguish from Judy's JC.

John C.

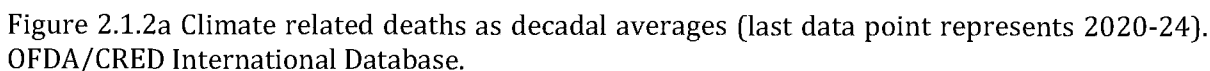
John Christy  
Director, Earth System Science Center  
Professor, Atmos and Earth Science  
Alabama State Climatologist  
The University of Alabama in Huntsville  
climatemanager60@gmail.com

**CONFIDENTIAL**  
**FOR DISCUSSION PURPOSES ONLY**

**Current Scientific Understanding of US Greenhouse Gas Emissions from Motor  
Vehicles as an Endangerment to US Citizens**

## Forecasting systems for extreme weather [JC]

The ability to reduce weather-related threats to human survival accelerated in the 20<sup>th</sup> century as seen in the dramatic drop in deathrates due to such threats (Fig. 2.1.2a). There are many aspects of human progress that explain this reduction such as, agricultural mechanization and irrigation, development of heartier plant and animal species, more robust infrastructure, electrification, transportation that delivers goods and services to meet demand, medical advances, ubiquitous real-time communication devices, etc. One component of this threat-reduction is the improving skill of weather forecasts, allowing the population to be forewarned of potentially dangerous weather and thus seek protection. South Asia, for example, because of extensive satellite coverage, will not again be surprised by land-falling cyclones such as Bhola in 1970 that killed between 300,000 and 500,000 people.



In the US, the forecasting skill of the National Weather Service and other service providers has made tremendous strides in the past 50 years. A recent example was the well-forecasted heatwave, unprecedented in last 150 years, in the Pacific NW in late June 2021 (Mass et al. 2024) for which residents and infrastructure-managers could prepare. In another example, hurricane

forecasts for US landfalls indicate the accuracy of a modern 5-day forecast exceeds the skill of a 2-day forecast from 1970 (Alley et al. 2019).

In addition to warning services provided by private industry to their customers, the US Federal Government maintains an observing system and forecasting platforms to alert the public to potentially dangerous events, then detect their occurrence and document the damage. The National Weather Service is generally the front-line communicator of these “hazardous” events which are followed in detail from various arms of the federal government including; (a) hurricanes (National Hurricane Center, Miami FL), (b) tornados and related phenomena - hail, high winds, lightning – (National Severe Storms Laboratory, Norman OK), (c) river flooding (Regional River Forecast Centers), (d) wildfires (NWS Fire Weather), (e) air pollution (US Environmental Protection Agency), and (f) coastal flooding (NOAA Office for Coastal Management). All of these sources of information reduce vulnerability to lives and to a lesser extent property.

However, other metrics which represent decisive influences on the reduction of weather-related deaths such as increases in global grain production, access to electricity, and general wealth and longevity make it difficult to quantify the improvements due to increasing forecast skill alone. Lazo et al. 2009 estimated that the overall benefit to US residents of general weather forecasts was \$31.5B at that time. Finally, the likelihood that Artificial Intelligence applications will provide targeted information that is more precise in both space and time and communicated through personal devices suggests even greater protection for US citizens in the coming years. (Lam et al. 2023).

Alley, R.B., K.A. Emanuel and F. Zhang, 2019. Science. 363, no. 6425 342-344.

Lazo, J.K., R.E. Morss, and J.L. Demuth, 2009. Bull. Am. Meteor. Soc., 90, 785.

Lam, R. et al., Learning skillful medium-range global weather forecasting. Science 382, 1416-1421 (2023). DOI: [10.1126/science.adi2336](https://doi.org/10.1126/science.adi2336)



On Apr 19, 2025, at 10:44 AM, Judith Curry <curry.judith@gmail.com> wrote:

See attached text for 2.1. I've changed the content for this section, to socioeconomic context for trend in "dangerous", and this includes brief description of how improved weather forecasting is saving lives and \$\$.

I think this is more relevant than a description of advances in forecasting extreme weather, let me know what think. If you are ok with this i will add to drop box

On Sat, Apr 19, 2025 at 7:28 AM Ross McKittrick <ross.mckittrick@gmail.com> wrote:

I also have some text on mortality impacts. Also I can add a bit to the vector-borne topic from my work on malaria a few years ago.

Sections 4.2 and 4.3 could easily be combined and build from what John already wrote.

Ross

On Sat, Apr 19, 2025 at 8:28 AM Judith Curry <curry.judith@gmail.com> wrote:

I can do 9 am (6 am PDT) for a call,

On Fri, Apr 18, 2025 at 7:57 PM Ross McKittrick <ross.mckittrick@gmail.com> wrote:

I'm thinking that a conference call or zoom meeting would be helpful so we can get caught up on the work done up to now and also the administrative side of things. Everything seems to be moving at a rapid pace. Could we schedule it for Monday morning at 9 ET?

Ross

On Fri, Apr 18, 2025 at 10:03 PM Travis Fisher <travis.scott.fisher@gmail.com> wrote:

Thanks so much, Judy!

Great questions. I don't think anyone has taken on the "air pollutant" issue. Please feel free to tackle it if you like!

Regarding the regulation in question, I've been told this summary of the science will be published as a technical support document relevant to a new proposed rule on tailpipe emissions standards for motor vehicles. I don't know whether that means all motor vehicles or just light- and medium-duty vehicles. It might be helpful to differentiate GHG emissions from the different classes to give the EPA flexibility in that regard.

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Keep the questions coming! I can run them up the chain if I don't know the answers, and I am happy to relay any questions you all have to the relevant folks at DOE or other agencies.

For your awareness, I was asked to share the table of contents with the EPA team this evening, which I did (the April 18 version), with the understanding that it is a one-way street (me informing them of your work so they know what's coming, not them sending

feedback or micro-managing it). As I assured Steve in the early stages of this work, scientific integrity is paramount, and I will do everything in my power to preserve every word of the document as you all write it. In fact, the EPA team asked that the document be DOE-branded, meaning our true audience is the Secretary of Energy, and he emphasized to me that he wants nothing but science. In other words, the only compromise you have to make in how this is written is among yourselves, not between you all and policymakers, lawyers, or economists.

Thanks again for lending your expertise to this effort, all of you.

Best,  
Travis

On Fri, Apr 18, 2025 at 8:46 PM Judith Curry <[curry.judith@gmail.com](mailto:curry.judith@gmail.com)> wrote:

I have a lot of material already written that should be relevant. I have a draft of the sea level rise section completed, am sending this to my assistant to format, will upload monday.

Roy, let me know if there are sections you can't complete, i may have some text that is already written

On Fri, Apr 18, 2025 at 3:06 PM Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:  
Good afternoon,

I'm happy to report that I just talked with Judy, and she accepted the mission (in case you're wondering, the vetting issue was a mishap). This is great news because the Secretary wanted all of you to be able to contribute.

Let's make sure to include Judy in all of our correspondence from now on. The documents should be available here: [https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyrr8x/ANTU1qAQJ-zXCFzP\\_gsJcOs?rlkey=11z3qj9v46e1t5f4ywwxq7p8c&e=1&dl=0](https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyrr8x/ANTU1qAQJ-zXCFzP_gsJcOs?rlkey=11z3qj9v46e1t5f4ywwxq7p8c&e=1&dl=0). Please let us know if you don't have access.

Best,  
Travis

On Fri, Apr 18, 2025 at 4:59 PM Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:

Thanks John. The quote from Mauritsen and Roeckner is a great addition. I find the figure hard to follow, whereas the quote makes the point very clearly, in their own words.

On Fri, Apr 18, 2025 at 4:55 PM John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)> wrote:  
Ross

I've never been successful with dropbox and my record is still intact.

Attached is 1.6.2 to which I added a paragraph.

Also attached is a chart I annotated from AR6. I think this story demonstrates

modelers are just playing with tuning parameters. Is there some way to use this information here (not necessarily in this format)?

John C.

<Fig\_AR6\_3.8\_Apr18[JC].png>

On Fri, Apr 18, 2025 at 3:32 PM Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:

I've uploaded a new version of Section 2.2 to your folder. It includes the earlier material quoting all the relevant IPCC and NCA17 stuff and adds some external source information I found. Still needs a brief summary. Others may have more to add.

On Fri, Apr 18, 2025 at 3:05 PM Roy Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)> wrote:

Ross:

Let me look early in the morning to see which ones I feel like I can knock out the fastest. Our "guidance" has been to start from "scratch", while relying on preexisting materials where it helps. I think I know why we've been told this, but it's not my place to say.

- Roy

Sent from my Verizon, Samsung Galaxy smartphone

----- Original message -----

From: Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>

Date: 4/18/25 10:49 AM (GMT-06:00)

To: Roy Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>

Cc: Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>, Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>, John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>

Subject: Re: I'll need help: 10 sections to go

Sorry Roy, I didn't mean to swamp you, I figured those were sections you already had in the can from previous work. Looking through my own folders I have some material I forgot I had written which I can repurpose. Can you send a list of the sections you are able to do, and the ones you would like to hand off for the time being?

Also to Travis' point we should look to having Judy help some of the sections. Travis, she can be reached via [curry.judith@gmail.com](mailto:curry.judith@gmail.com)

Ross

On Fri, Apr 18, 2025 at 7:40 AM Roy Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)> wrote:

All:

I don't see how I'm going to do the 10 more sections assigned to me (1.6.1 onward) in the time remaining. Feel free to jump in.

-Roy

---

**From:** Roy Spencer <roywspencer@hotmail.com>  
**Sent:** Friday, April 18, 2025 6:34 AM  
**To:** Ross McKittrick <ross.mckittrick@gmail.com>; Travis Fisher <travis.scott.fisher@gmail.com>  
**Cc:** Steven Koonin <steven.koonin@gmail.com>; John Christy <climateman60@gmail.com>  
**Subject:** Section 1.4.3 attached

Ross:

I think we should combine sections 1.4.3 and 1.4.4 (attached) which I now call "The carbon cycle, emissions scenarios, and global greening".

I found that all of these need to be discussed together. Feel free to reword the section title.

-Roy

---

**From:** Roy Spencer <roywspencer@hotmail.com>  
**Sent:** Thursday, April 17, 2025 6:17 AM  
**To:** Ross McKittrick <ross.mckittrick@gmail.com>; Travis Fisher <travis.scott.fisher@gmail.com>  
**Cc:** Steven Koonin <steven.koonin@gmail.com>; John Christy <climateman60@gmail.com>  
**Subject:** Section 1.4.2 Can climate models reproduce the recent past?

Attached. This is the minimum I think needs to be in this section. Of course, more could be added, but I think we need to stick to our strongest arguments, given the limited time available.

-Roy

---

**From:** Roy Spencer <roywspencer@hotmail.com>  
**Sent:** Wednesday, April 16, 2025 7:16 AM  
**To:** Ross McKittrick <ross.mckittrick@gmail.com>; Travis Fisher <travis.scott.fisher@gmail.com>  
**Cc:** Steven Koonin <steven.koonin@gmail.com>; John Christy <climateman60@gmail.com>  
**Subject:** Some Spencer inputs

I took it upon myself to write a preamble in **Section 1.3 Drivers of climate change** (attached), which seemed necessary to introduce some basic concepts.

Also attached are my initial submissions for **1.3.2** and **1.3.3**.

**NO references** added yet.

One of the things I believe we need to watch out for is *neglecting to come to conclusions along the way*... There is a tendency to get mired in the technical details without getting around to saying what each section might mean in eventual policy decisions related to the Endangerment Finding. In my experience, it is not possible to dumb-down this stuff too much. I suggest some sort of "Summary Boxes" with 1-2 simplified statements highlighting a main conclusion of each section that would have policy relevance.

--Roy

---

**From:** Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>  
**Sent:** Monday, April 14, 2025 1:37 PM  
**To:** Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>  
**Cc:** Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>; John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>; [roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)  
<[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>  
**Subject:** Re: Kickoff

Hi Travis

We developed the outline a bit further and assigned sections out yesterday. We'll keep you cc'd going forward.

Here is a Dropbox link that contains the current outline (also attached) which indicates who is working on each section

[https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyrrri8x/ANTU1qAQJ-zXCFzP\\_gsJcOs?rlkey=11z3qj9v46e1t5f4ywwxq7p8c&dl=0](https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyrrri8x/ANTU1qAQJ-zXCFzP_gsJcOs?rlkey=11z3qj9v46e1t5f4ywwxq7p8c&dl=0)  
The link should give you all editing privileges.

I put folders in there for each of us. If the use of that Dropbox (which is on my own account) is acceptable for this project then we can share our work using it. Otherwise once we have an official Dropbox created we can transfer the material over to it.

Do you think it would be helpful to have a section specifically addressing the question of whether CO2 is a pollutant like CO, NOx, SOx, PM, etc.? If you want to add topics or suggest changes please do, the earlier the better as we begin filling out the contents.

Cheers,

Ross

On Mon, Apr 14, 2025 at 2:12 PM Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:

This is an excellent start! Can we move forward by iterating with this document for now? Please feel free to add whatever material you like, and I can collate if there are any simultaneous changes. I will leave the substance to you all because I view my role as a facilitator rather than a contributor, but please let me know how I can be most helpful.

Steve is correct that this document should be clear and understandable for non-experts. My understanding is that it should also be sufficiently

technical and comprehensive to inform policymakers on all relevant aspects of the science.

One area I can help with might be targeting your work for the very brief window we have open at the moment. I am including a few lines verbatim below from key documents to highlight the areas of inquiry that are most relevant to the policymaking process. Of course, you all should make your own judgments about what to include versus what to leave out.

Here is a key section of the Clean Air Act, 202(a)(1): "The Administrator shall by regulation prescribe (and from time to time revise) in accordance with the provisions of this section, standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare. Such standards shall be applicable to such vehicles and engines for their useful life (as determined under subsection (d), relating to useful life of vehicles for purposes of certification), whether such vehicles and engines are designed as complete systems or incorporate devices to prevent or control such pollution."

Section 202 can be found [here](#).

Here is another key section of the Clean Air Act, section 302(g): "The term 'air pollutant' means any air pollution agent or combination of such agents, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and byproduct material) substance or matter which is emitted into or otherwise enters the ambient air. Such term includes any precursors to the formation of any air pollutant, to the extent the Administrator has identified such precursor or precursors for the particular purpose for which the term 'air pollutant' is used."

A threshold question raised in Justice Scalia's dissent in *Mass v. EPA* (which can be found [here](#)) is whether CO<sub>2</sub> falls under the definition of an "air pollutant" under the Clean Air Act. The majority in *Mass v. EPA* found that *any* compound emitted into the ambient air fits the definition of "air pollutant," leading to a colorful footnote in the Scalia dissent ("It follows that everything airborne, from Frisbees to flatulence, qualifies as an 'air pollutant.' This reading of the statute defies common sense."). A scientific interpretation of this definition could be very helpful.

The next section in the statute is 302(h), which defines effects on welfare: "All language referring to effects on welfare includes, but is not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants." Positive impacts, including fertilization effects and beneficial warming, seem to be within scope here.

Section 302 can be found [here](#).

As you all develop the draft, I encourage you to include as many citations to published materials as possible (links would work fine as placeholders). I have found this works better under a tight timeline than going back and looking for sources later. Please also feel free to task me with any research help you might need.

Best,  
Travis

On Fri, Apr 11, 2025 at 8:10 PM Steven Koonin

<[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)> wrote:

I assume we're writing for non-experts. If so, some educating beyond the root questions is in order (it always helps if people feel smarter after reading).

So I've taken Ross' material, added some broader context, and cast it into the forcing/response/impact syllogism that most non-experts seem to get. The result is attached.

I think we can deal with the differences relative to 2009 in an appendix.

SEK

---

**From:** John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>

**Sent:** Friday, April 11, 2025 6:34 PM

**To:** Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>

**Cc:** Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>;  
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**Subject:** Re: Kickoff

Excellent list Ross. Wildfires are a significant topic to be addressed.

John C.

Sent from my iPhone

On Apr 11, 2025, at 4:05 PM, Ross McKittrick  
<[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:

The attached represents my summary of the most questions needing to be answered, which I think this group is capable of answering in the next couple of weeks. Probably lots of material already in hand.

On Fri, Apr 11, 2025 at 4:24 PM Travis Fisher  
<[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:

Gentlemen,

I can't thank you enough for taking this on under such a tight timeline. Let's use this thread to exchange information, links, etc., and as we move forward, I'll see about a document-sharing platform and a shared document to work on simultaneously.

Best,  
Travis

<DE.memo.outline.Apr.11.[RM].docx>



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<Dangerous DOE 2.docx>



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**Sent:** Saturday, April 19, 2025 11:44 AM  
**To:** Ross McKittrick  
**Cc:** Travis Fisher; John Christy; Roy Spencer; Steven Koonin  
**Subject:** Section 2.1  
**Attachments:** Dangerous DOE 2.docx

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Thanks again for lending your expertise to this effort, all of you.

Best,  
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I find the figure hard to follow, whereas the quote makes the point very clearly, in their own words.

On Fri, Apr 18, 2025 at 4:55 PM John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)> wrote:

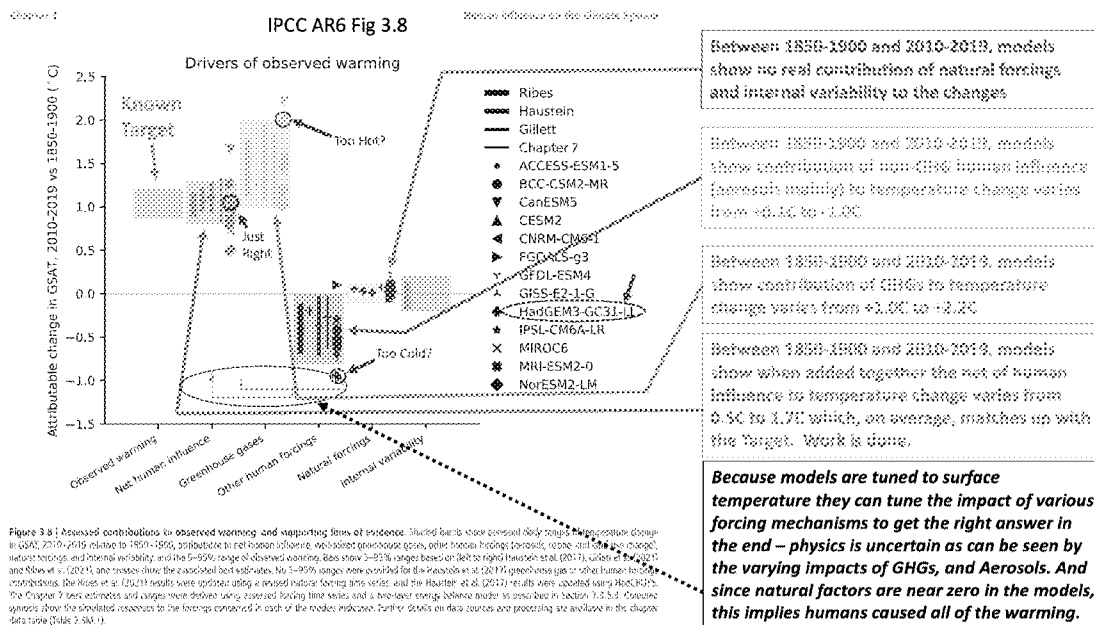
Ross

I've never been successful with dropbox and my record is still intact.

Attached is 1.6.2 to which I added a paragraph.

Also attached is a chart I annotated from AR6. I think this story demonstrates modelers are just playing with tuning parameters. Is there some way to use this information here (not necessarily in this format)?

John C.



On Fri, Apr 18, 2025 at 3:32 PM Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:  
I've uploaded a new version of Section 2.2 to your folder. It includes the earlier material quoting all the relevant IPCC and NCA17 stuff and adds some external source information I found. Still needs a brief summary. Others may have more to add.

On Fri, Apr 18, 2025 at 3:05 PM Roy Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)> wrote:

Ross:

Let me look early in the morning to see which ones I feel like I can knock out the fastest. Our "guidance" has been to start from "scratch", while relying on preexisting materials where it helps. I think I know why we've been told this, but it's not my place to say.

- Roy

Sent from my Verizon, Samsung Galaxy smartphone

----- Original message -----

From: Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>

Date: 4/18/25 10:49 AM (GMT-06:00)

To: Roy Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>

Cc: Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>, Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>, John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>

Subject: Re: I'll need help: 10 sections to go

Sorry Roy, I didn't mean to swamp you, I figured those were sections you already had in the can from previous work. Looking through my own folders I have some material I forgot I had written which I can repurpose. Can you send a list of the sections you are able to do, and the ones you would like to hand off for the time being?

Also to Travis' point we should look to having Judy help some of the sections. Travis, she can be reached via [curry.judith@gmail.com](mailto:curry.judith@gmail.com)

Ross

On Fri, Apr 18, 2025 at 7:40 AM Roy Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)> wrote:  
All:

I don't see how I'm going to do the 10 more sections assigned to me (1.6.1 onward) in the time remaining. Feel free to jump in.

-Roy

---

**From:** Roy Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>  
**Sent:** Friday, April 18, 2025 6:34 AM  
**To:** Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>; Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>  
**Cc:** Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>; John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>  
**Subject:** Section 1.4.3 attached

Ross:

I think we should combine sections 1.4.3 and 1.4.4 (attached) which I now call "The carbon cycle, emissions scenarios, and global greening".

I found that all of these need to be discussed together. Feel free to reword the section title.

-Roy

---

**From:** Roy Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>  
**Sent:** Thursday, April 17, 2025 6:17 AM  
**To:** Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>; Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>  
**Cc:** Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>; John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>  
**Subject:** Section 1.4.2 Can climate models reproduce the recent past?

Attached. This is the minimum I think needs to be in this section. Of course, more could be added, but I think we need to stick to our strongest arguments, given the limited time available.

-Roy

---

**From:** Roy Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>  
**Sent:** Wednesday, April 16, 2025 7:16 AM  
**To:** Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>; Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>

**Cc:** Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>; John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>

**Subject:** Some Spencer inputs

I took it upon myself to write a preamble in **Section 1.3 Drivers of climate change** (attached), which seemed necessary to introduce some basic concepts.

Also attached are my initial submissions for **1.3.2** and **1.3.3**.

**NO references** added yet.

One of the things I believe we need to watch out for is *neglecting to come to conclusions along the way...* There is a tendency to get mired in the technical details without getting around to saying what each section might mean in eventual policy decisions related to the Endangerment Finding. In my experience, it is not possible to dumb-down this stuff too much. I suggest some sort of "Summary Boxes" with 1-2 simplified statements highlighting a main conclusion of each section that would have policy relevance.

-Roy

---

**From:** Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>

**Sent:** Monday, April 14, 2025 1:37 PM

**To:** Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>

**Cc:** Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>; John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>; roywspencer@hotmail.com <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>

**Subject:** Re: Kickoff

Hi Travis

We developed the outline a bit further and assigned sections out yesterday. We'll keep you cc'd going forward.

Here is a Dropbox link that contains the current outline (also attached) which indicates who is working on each section

[https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyrr8x/ANTU1qAQJ-zXCFzP\\_gsJcOs?rlkey=1lz3qj9v46e1t5f4ywwxq7p8c&dl=0](https://www.dropbox.com/scl/fo/wahx6lpwzu33m5vyrr8x/ANTU1qAQJ-zXCFzP_gsJcOs?rlkey=1lz3qj9v46e1t5f4ywwxq7p8c&dl=0)

The link should give you all editing privileges.

I put folders in there for each of us. If the use of that Dropbox (which is on my own account) is acceptable for this project then we can share our work using it. Otherwise once we have an official Dropbox created we can transfer the material over to it.

Do you think it would be helpful to have a section specifically addressing the question of whether CO2 is a pollutant like CO, NOx, SOx, PM, etc.? If you want to add topics or suggest changes please do, the earlier the better as we begin filling out the contents.

Cheers,

Ross

On Mon, Apr 14, 2025 at 2:12 PM Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:

This is an excellent start! Can we move forward by iterating with this document for now? Please feel free to add whatever material you like, and I can collate if there are any simultaneous changes. I

will leave the substance to you all because I view my role as a facilitator rather than a contributor, but please let me know how I can be most helpful.

Steve is correct that this document should be clear and understandable for non-experts. My understanding is that it should also be sufficiently technical and comprehensive to inform policymakers on all relevant aspects of the science.

One area I can help with might be targeting your work for the very brief window we have open at the moment. I am including a few lines verbatim below from key documents to highlight the areas of inquiry that are most relevant to the policymaking process. Of course, you all should make your own judgments about what to include versus what to leave out.

Here is a key section of the Clean Air Act, 202(a)(1): "The Administrator shall by regulation prescribe (and from time to time revise) in accordance with the provisions of this section, standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare. Such standards shall be applicable to such vehicles and engines for their useful life (as determined under subsection (d), relating to useful life of vehicles for purposes of certification), whether such vehicles and engines are designed as complete systems or incorporate devices to prevent or control such pollution."

Section 202 can be found [here](#).

Here is another key section of the Clean Air Act, section 302(g): "The term 'air pollutant' means any air pollution agent or combination of such agents, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and byproduct material) substance or matter which is emitted into or otherwise enters the ambient air. Such term includes any precursors to the formation of any air pollutant, to the extent the Administrator has identified such precursor or precursors for the particular purpose for which the term 'air pollutant' is used."

A threshold question raised in Justice Scalia's dissent in *Mass v. EPA* (which can be found [here](#)) is whether CO<sub>2</sub> falls under the definition of an "air pollutant" under the Clean Air Act. The majority in *Mass v. EPA* found that *any* compound emitted into the ambient air fits the definition of "air pollutant," leading to a colorful footnote in the Scalia dissent ("It follows that everything airborne, from Frisbees to flatulence, qualifies as an 'air pollutant.' This reading of the statute defies common sense."). A scientific interpretation of this definition could be very helpful.

The next section in the statute is 302(h), which defines effects on welfare: "All language referring to effects on welfare includes, but is not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants." Positive impacts, including fertilization effects and beneficial warming, seem to be within scope here.

Section 302 can be found [here](#).

As you all develop the draft, I encourage you to include as many citations to published materials as possible (links would work fine as placeholders). I have found this works better under a tight timeline than going back and looking for sources later. Please also feel free to task me with any research help you might need.

Best,  
Travis

On Fri, Apr 11, 2025 at 8:10 PM Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)> wrote:

I assume we're writing for non-experts. If so, some educating beyond the root questions is in order (it always helps if people feel smarter after reading).

So I've taken Ross' material, added some broader context, and cast it into the forcing/response/impact syllogism that most non-experts seem to get. The result is attached.

I think we can deal with the differences relative to 2009 in an appendix.

SEK

---

**From:** John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>

**Sent:** Friday, April 11, 2025 6:34 PM

**To:** Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)>

**Cc:** Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)>; [steven.koonin@gmail.com](mailto:steven.koonin@gmail.com); [roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)

**Subject:** Re: Kickoff

Excellent list Ross. Wildfires are a significant topic to be addressed.

John C.

Sent from my iPhone

On Apr 11, 2025, at 4:05 PM, Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:

The attached represents my summary of the most questions needing to be answered, which I think this group is capable of answering in the next couple of weeks. Probably lots of material already in hand.

On Fri, Apr 11, 2025 at 4:24 PM Travis Fisher <[travis.scott.fisher@gmail.com](mailto:travis.scott.fisher@gmail.com)> wrote:

Gentlemen,

I can't thank you enough for taking this on under such a tight timeline. Let's use this thread to exchange information, links, etc., and as we move forward, I'll see about a document-sharing platform and a shared document to work on simultaneously.

Best,  
Travis

<DE.memo.outline.Apr.11.[RM].docx>



Judith Curry, President  
CFAN - Climate Forecast Applications Network  
Reno, NV USA  
[curry.judith@cfanclimate.com](mailto:curry.judith@cfanclimate.com) | +1.404.803.2012  
<http://www.cfanclimate.net>



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<http://www.cfanclimate.net>



## **2. Has the U.S. climate become more dangerous over time?**

Notions of “dangerous climate change” relate to climate change risk. The IPCC defines climate change risk as the dynamic association of the three core elements of risk: hazard, exposure, and vulnerability. Hazard captures the frequency and intensity of extreme weather and climate events or slowly emerging change such as sea level rise. Exposure refers to the elements of population, infrastructures, and social welfare at risk. Vulnerability refers to the exposures’ potential to suffer as well as its ability to manage, withstand and rebound. Risks from human-caused climate change are convoluted with natural weather and climate variability, and are dominated by the exposure of wealth in coastal and other disaster-prone regions and vulnerabilities of poorer populations.

### ***2.1 Socioeconomic context***

The evolution of climate risk in the U.S. has been dominated by societal factors, rather than by changes to the actual weather and climate hazards. Deaths from weather disasters have decreased substantially since 1900, even as US population grew from 76 million in 1900 to over 331 million in 2020. For example, the Galveston hurricane killed over 8,000 people in 1900 (0.01% of the US population), whereas the worst recent disaster, Hurricane Katrina in 2005, killed 1800 people (or 0.0006% of the US population).

Since 1980, NOAA has provided a count of annual U.S. weather-related disasters that it estimates to have exceeded \$1Billion (inflation adjusted), showing a substantial increase starting in 2008. Over time, population and wealth have increased dramatically in the US, so that when an extreme weather or climate event occurs, there is more damage even if there is no underlying trend in the frequency or intensity of extreme weather. A recent estimate finds that losses per weather disaster are down by about 80% since 1980, as a proportion of GDP. <https://drive.google.com/file/d/1MvgwcWaimcn1oHODqNZDG1fXF4M5Idnn/view> By adjusting for inflation, but not for changes in exposure or vulnerability, the NOAA billion dollar data set reflects the growth in population and wealth, which swamps any changes in actual weather hazards. While absolute losses from weather and climate disasters have grown, they are a smaller fraction of GDP today, reflecting economic growth outpacing disaster-related costs.

Technological advances have substantially reduced losses from extreme weather events. Early warning systems, satellite monitoring, and improved weather forecasting have reduced deaths, although exact numbers are hard to quantify. <https://www.nber.org/papers/w31361> US weather forecasting has been estimated to reduce losses from weather events with an annualized benefit of \$31.5B, protecting lives, property, and supporting agriculture and transportation <https://nap.nationalacademies.org/read/12888/chapter/2> Improved hurricane forecasts have reduced pre- and post-landfall spending, with annual per hurricane cost reductions estimated at \$5B <https://www.nber.org/digest/202409/value-improving-hurricane-forecasts>

Infrastructure improvements have contributed to substantial reductions in losses from extreme weather events. Building codes, such as those implemented in Florida after Hurricane Andrew

(1992) have reduced losses by ensuring structures can withstand high winds and floods. Homes built after 2002 showed minimal damage during Hurricane Michael (2018), unlike older homes. <https://www.fema.gov/case-study/role-floridas-building-codes-2018-hurricane-michael>. Sea walls, like the Galveston Seawall, protect against wave action and storm surge. The New Orleans Hurricane and Storm Damage Risk Reduction System successfully mitigated storm surge during Hurricane Isaac (2012). Inland dams in the US help control flooding by storing excess water during heavy rains. It is estimated that the Tennessee Valley Authority (TVA) dams prevent about \$309M in annual flood damage in the TVA region and along the Ohio and Mississippi Rivers <https://www.tva.com/environment/managing-the-river/flood-management>. During Hurricane Helene (2024), TVA's strategies prevented approximately \$406M in potential damages. <https://www.publicpower.org/periodical/article/tva-flood-mitigation-strategies-prevented-approximately-406-million-potential-damages>

In summary, trends in losses from extreme weather and climate events are dominated by population increases and economic growth. Technological advances such as improved weather forecasting and early warning systems have substantially reduced losses from extreme weather events. Better building codes, flood defenses, and disaster response mechanisms have lowered economic losses relative to GDP. And finally, the US economy's expansion has diluted the relative impact of disaster costs, as seen in the comparison of historical and modern GDP percentages.

---

**From:** Ross McKittrick [ross.mckittrick@gmail.com]  
**Sent:** 4/13/2025 2:10:58 PM  
**To:** John Christy [climateman60@gmail.com]  
**CC:** Roy Spencer [roywspencer@hotmail.com]; Steven Koonin [steven.koonin@gmail.com]  
**Subject:** Re: Saturday Apr 12 draft

John: For sections 2.1.2 and 2.1.3 I'm thinking of any forecasting tools that help mitigate disasters, e.g. systems for forecasting hurricane tracks for evacuation purposes, tornado warning systems, blizzard warnings, heat wave and cold snap warnings etc. Also if medium-range modeling provides any useful guidance.  
Ross

On Sun, Apr 13, 2025 at 9:33 AM John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)> wrote:  
Ross

A question: what is meant by "Forecasting extremes"?

John C.

Sent from my iPhone

On Apr 13, 2025, at 7:51 AM, Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:

3) On further thought, since we will soon have a very long document to grapple with, I suggest everyone create each assigned subsection as a separate Word document and work away at it independently for now. We need to aim to have section drafts ready by, say, the 18th, by which time we should have a Dropbox folder available and we can then look at each others' drafts and make suggestions. By the 26th or so we can assemble a full draft and start final edits.

Since we may occasionally want to refer to a discussion in another part of the document, before going much further can everyone look at the list of sections and subsections and indicate if anything is missing? It's easy to insert new sections now, but if we start saying things like "As discussed in Section 3.2.5" it gets to be a challenge if that section has since been renumbered and is now 3.2.7.

On Sun, Apr 13, 2025 at 8:30 AM Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:

1) Group editing is always a challenge. I don't know what Travis will set up for us but for now I suggest we use a formatted title like the attached: Date\_time.[initials].

In the attached version I have separated each section to start on a new page, so each person's turf is clearly separated, for the initial drafting. As long as everyone focuses on their sections and uses the naming format I can make sure periodically we have updated drafts with everyone's current text included.

2) My suggestion for references is Author[date] Endnote format and each of us create a separate document <References.Name> where you accumulate all your citations. Then we can merge them at the end and add a single list of endnote references. We'll have to include data sources which can be cumbersome. That raises the issue of whether we will have any admin support to make the document pretty and standardize the reference formats. Something tells me no one has thought of that.

On Sun, Apr 13, 2025 at 6:00 AM Roy Spencer <roywspencer@hotmail.com> wrote:

1. Will we be working from a common document accessible to all simultaneously? In the past I've run into issues with this, but I'm sure people have found a way to make it work.... If we are each responsible for separate sections, this should be cleaner without everyone editing over each others' words.
2. How should references be handled? (Word footnotes, citations, or just Author [date] manually sorted at the end? Do we worry about a common format for references?

-Roy

---

**From:** Ross McKittrick <ross.mckittrick@gmail.com>

**Sent:** Saturday, April 12, 2025 9:13 AM

**To:** Steven Koonin <steven.koonin@gmail.com>; Roy W. Spencer <roywspencer@hotmail.com>; John Christy <climateman60@gmail.com>

**Subject:** Saturday Apr 12 draft

I've taken Steve's suggested outline and added some sections based on another summary document someone sent me earlier. In the attached Word document the section titles are entered using heading formats so a Table of Contents can be automatically generated as shown. In other words don't edit the Table of Contents, if you want to rename a section edit the title where it appears in the text. The ToC can be updated by right-clicking and selecting Update Field.

I have indicated my suggestions for who should take the lead in inserting text in each section based on who I think probably has material to hand already, or can produce something quickly. However everyone will have a chance to contribute to every section before we are finished, so the suggestion is just for the purpose of getting the ball rolling. Also we can add sections if you think something is missing.

From another project I worked on previously I already have summaries regarding extreme weather from all IPCC reports since SREX in 2012 so I will go ahead and insert those.

Cheers,

Ross

---

**From:** Roy Spencer <roywspencer@hotmail.com>  
**Sent:** Sunday, April 13, 2025 9:51 AM  
**To:** Ross McKitrick  
**Cc:** Steven Koonin; John Christy  
**Subject:** RE: Saturday Apr 12 draft

Ross, I like that solution better. - Roy

Sent from my Verizon, Samsung Galaxy smartphone

----- Original message -----

From: Ross McKitrick <ross.mckitrick@gmail.com>  
Date: 4/13/25 7:51 AM (GMT-06:00)  
To: Roy Spencer <roywspencer@hotmail.com>  
Cc: Steven Koonin <steven.koonin@gmail.com>, John Christy <climateman60@gmail.com>  
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**To:** Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>; Roy W. Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>; John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>

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-Roy

---

**From:** Ross McKitrick <[ross.mckitrick@gmail.com](mailto:ross.mckitrick@gmail.com)>  
**Sent:** Saturday, April 12, 2025 9:13 AM

**To:** Steven Koonin <[steven.koonin@gmail.com](mailto:steven.koonin@gmail.com)>; Roy W. Spencer <[roywspencer@hotmail.com](mailto:roywspencer@hotmail.com)>; John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)>

**Subject:** Saturday Apr 12 draft

I've taken Steve's suggested outline and added some sections based on another summary document someone sent me earlier. In the attached Word document the section titles are entered using heading formats so a Table of Contents can be automatically generated as shown. In other words don't edit the Table of Contents, if you want to rename a section edit the title where it appears in the text. The ToC can be updated by right-clicking and selecting Update Field.

I have indicated my suggestions for who should take the lead in inserting text in each section based on who I think probably has material to hand already, or can produce something quickly. However everyone will have a chance to contribute to every section before we are finished, so the suggestion is just for the purpose of getting the ball rolling. Also we can add sections if you think something is missing.

From another project I worked on previously I already have summaries regarding extreme weather from all IPCC reports since SREX in 2012 so I will go ahead and insert those.

Cheers,

Ross



---

**From:** Ross McKittrick [ross.mckittrick@gmail.com]  
**Sent:** 4/13/2025 12:30:42 PM  
**To:** Roy Spencer [roywspencer@hotmail.com]  
**CC:** Steven Koonin [steven.koonin@gmail.com]; John Christy [climateman60@gmail.com]  
**Subject:** Re: Saturday Apr 12 draft  
**Attachments:** Outline.Apr13\_8.22AM.[RM].docx

1) Group editing is always a challenge. I don't know what Travis will set up for us but for now I suggest we use a formatted title like the attached: Date\_time.[initials].

In the attached version I have separated each section to start on a new page, so each person's turf is clearly separated, for the initial drafting. As long as everyone focuses on their sections and uses the naming format I can make sure periodically we have updated drafts with everyone's current text included.

2) My suggestion for references is Author[date] Endnote format and each of us create a separate document <References.Name> where you accumulate all your citations. Then we can merge them at the end and add a single list of endnote references. We'll have to include data sources which can be cumbersome. That raises the issue of whether we will have any admin support to make the document pretty and standardize the reference formats. Something tells me no one has thought of that.

On Sun, Apr 13, 2025 at 6:00 AM Roy Spencer <roywspencer@hotmail.com> wrote:

1. Will we be working from a common document accessible to all simultaneously? In the past I've run into issues with this, but I'm sure people have found a way to make it work.... If we are each responsible for separate sections, this should be cleaner without everyone editing over each others' words.
2. How should references be handled? (Word footnotes, citations, or just Author [date] manually sorted at the end? Do we worry about a common format for references?

-Roy

---

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**Sent:** Saturday, April 12, 2025 9:13 AM  
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Ross

**CONFIDENTIAL**  
**FOR DISCUSSION PURPOSES ONLY**

**Current Scientific Understanding of US Greenhouse Gas Emissions from Motor  
Vehicles as an Endangerment to US Citizens**

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# **1 Introduction**

## **1.1 Definition of climate [SK]**

- Climate is the long-term stats of weather. Typically 30 years. It involves averages, variations, extreme events. The weather any one year does not a climate make
- There are other components of the climate beyond the atmosphere – oceans are very important, ice, biosphere, solid earth

## **1.2 How climate conditions are measured [JC]**

- Poor records in the past – the earth is big, the ocean largely unobserved
- Modern day measurement systems for temperature and precipitation

## **1.3 Drivers of climate change**

### **1.3.1 Natural internal variability [SK]**

- The climate varies a lot on its own
  - From place to place
  - From time to time via internal dynamics
  - Interacting nonlinear chaotic systems



### **1.3.2 Natural externally forced changes [RS]**

Text text text.

### **1.3.3 Anthropogenically-forced changes [RS]**

Text text text.

## **1.4 Modeling the climate system**

### **1.4.1 Outline of climate model construction [SK]**

Text text text.

#### **1.4.2 Can climate models reproduce the recent past? [RS]**

Text text text.

### **1.4.3 Modeling the carbon cycle [RS]**

Text text text.

#### **1.4.4 Emission scenarios and climate projections [RS]**

Text text text.

## 1.5 Proving causation in climate change

### 1.5.1 The IPCC fingerprinting method [RM]

Climate “fingerprinting” as practiced by the IPCC uses regression models of the form

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{u} \quad [1]$$

in which  $\mathbf{y}$  is an  $\ell$ -length vector of observed climate indicators, such as trends in local temperatures over a sample of  $\ell$  surface gridcells,  $\mathbf{X}$  is an  $\ell \times m$  matrix of climate model-generated analogues (in other words replications of  $\mathbf{y}$  generated by a climate model under alternative assumptions about climate forcings),  $\boldsymbol{\beta}$  is a vector of  $m$  regression coefficients and  $\mathbf{u}$  is the random component with an unknown covariance matrix  $E(\mathbf{u}\mathbf{u}^T) = \mathbf{C}_N$ . In a 2-signal model one column of  $\mathbf{X}$  is generated under anthropogenic forcing and the other under natural forcing and the columns are referred to as “signals”. If an element of  $\boldsymbol{\beta}$  is significantly different from 0 the corresponding signal is said to be “detected”, which is interpreted as causal attribution between the forcing input for that column of  $\mathbf{X}$  and the climate feature as measured in  $\mathbf{y}$ . The coefficient magnitude indicates the multiplicative adjustment required to make the model signals align with observations. If the coefficient is close to 1.0 this is taken to mean that the climate model accurately reproduces the effect of the associated forcing on the climate. If the coefficient is less than 1.0 that implies the model generates a too-strong climate impact for the forcing. For instance, if the coefficient is 0.5 that means the model signal has to be scaled down by 0.5 to optimally fit the observations; and likewise if the coefficient is greater than 1.0 that means the model underestimates the forcing strength.

Allen and Tett (1999, herein AT99) discussed the problem that heteroskedastic noise in the climate system might yield inaccurate variance estimates thus impeding signal detection. Despite that statistical problem having been solved 20 years previously in the econometrics literature (White 1980) Allen and Tett (1999) proposed an *ad hoc* and rather cumbersome procedure which was immediately adopted by the IPCC and the climate science community generally. They proposed estimating  $\mathbf{C}_N$  using  $\widehat{\mathbf{C}}_N = (\mathbf{P}^{(\kappa)T} \mathbf{P}^{(\kappa)})^+$  where  $+$  denotes the Moore-Penrose pseudo-inverse and the  $\mathbf{P}$ 's are formed using the first  $\kappa$  eigenvectors of temperatures from the preindustrial control run of a climate model weighted by their inverse square root eigenvalues (singular values). AT99 recommended running the matrix-weighted regression

$$\mathbf{P}^{(\kappa)} \mathbf{y} = \mathbf{P}^{(\kappa)} \mathbf{X} \boldsymbol{\beta} + \mathbf{P}^{(\kappa)} \mathbf{u} \quad [2]$$

AT99 termed this “optimal fingerprinting” and asserted that the estimator

$$\tilde{\boldsymbol{\beta}} = (\mathbf{X}^T \mathbf{P}^{(\kappa)T} \mathbf{P}^{(\kappa)} \mathbf{X})^{-1} \mathbf{X}^T \mathbf{P}^{(\kappa)T} \mathbf{P}^{(\kappa)} \mathbf{y} \quad [3]$$

satisfies the Gauss-Markov (GM) conditions and is therefore “BLUE”, or a Best (minimum variance) Linear Unbiased Estimator of  $\boldsymbol{\beta}$ . Allen and Stott (2003, herein AS03) noted that the columns of  $\mathbf{X}$  measure the unknown climate signals with error which can cause the  $\boldsymbol{\beta}$  to be biased downwards. Here again the solution to that problem was already well known in the econometrics literature (the Instrumental Variables (IV) method) whereas AS03 proposed a different method called Total Least Squares (TLS) or orthogonal regression. We can denote the combination of  $\mathbf{P}$ -weighting and TLS estimation as P-TLS. Note that almost all the greenhouse gas attribution studies since AT99, on which the IPCC’s iconic statements attributing most observed warming to anthropogenic forcing, are based on applications of the P-TLS method.

McKittrick (2022a, herein M22a) noted that AT99 erred in their description of the GM conditions and the estimator [2] fails to satisfy them, thus invalidating the AT99 claim that their method provides an efficient and unbiased estimator. AT99 also introduced a specification test they called the Residual Consistency Test (RCT). In the optimal fingerprinting literature this has been the only regression specification test used. M22a criticized the presentation in AT99 for failing to state a clear null hypothesis and failing to provide a formal distribution. Chen et al. (2023, herein C23) showed that it was possible to conjecture what the null hypothesis is, but that the distribution proposed in AT99 was inexact (the critical values were only valid asymptotically) which implies its application up to now has been unreliable. Furthermore, as noted in M22a, it provides no information regarding standard specification errors such as Omitted Variables Bias or Endogeneity Bias.

M22a listed five conditions that would need to be proven for the AT99 method to be considered consistent and BLUE. C23 confirmed the main elements of the M22a critique and provided a set of sufficient conditions for the estimator in equation [2] to be unbiased and consistent. (*Consistency* in statistical theory means that as the sample size goes to infinity, any bias in the estimator disappears and the variance goes to zero). McKittrick (2025) showed that the conditions are so onerous, however, that they can never be fulfilled in practice.

McKittrick (2022b, 2023) also showed that in climate fingerprinting applications TLS can overcorrect and impart an upward bias especially when the signals are negatively correlated, and it cannot be used to test the null because the estimator is undefined when  $\beta = 0$ . Taken together these criticisms imply that the IPCC fingerprinting method in widespread use since AT99 does not yield consistent test of signal detection, and the many published results from its application therefore do not provide valid information about the influence of GHGs on the climate system.

McKittrick (2025) summarized the discussions around the optimal fingerprinting method and presented an empirical example comparing the results of its application against standard methods with proven consistency properties, namely IV estimation with Heteroskedasticity and Spatial Autocorrelation-Consistent (HSAC) standard errors. While the IPCC method yields an anthropogenic signal coefficient close to 1.0 on a global temperature data set spanning 1900 to 2010, IV estimation yields a coefficient around 0.4, which rises to about 0.65 on data spanning 1980 to 2010, implying the model response to greenhouse gases needs to be scaled down by 40 to 60 percent to optimally match observations. The natural forcing signal coefficient when using the IV method falls between 2.0 and 4.0, implying the climate model signals of natural forcing need to be scaled up by at least double to match the attributable component of observed climate change.

Consequently the IPCC's claim of high confidence that most observed warming in recent decades can be attributed to greenhouse gases is now known to rest on invalid statistical foundations and needs to be set aside for the time being while more valid regression methods are brought to bear on the problem. Also, it should be noted that even if the regression method is valid, all such studies can provide is an indication that a pattern of observed changes is consistent with a particular set of (optimally rescaled) climate model outputs. It does not exclude the possibility that the model might be right for the wrong reasons, although the application in McKittrick (2025) is supported by numerous standard specification tests that help rule out some common regression model misspecifications.



### **1.5.2 Time series methods [RM]**

Text text text.

## **1.6 Measuring climate sensitivity to forcing**

### **1.6.1 Model-based methods [RS]**

Text text text.

### **1.6.2 Empirical methods [RM]**

Text text text.

## **1.7 Summary**

Text text text.

## **2 Has the US climate become more dangerous over time?**

### **2.1 How do people adapt to weather hazards and have they reduced climate-related risks?**

### **2.1.1 Mortality risks from extreme heat and cold [RS]**

Text text text.

### **2.1.2 Forecasting systems for extreme weather [JC]**

Text text text.

### **2.1.3 Other adaptation measures [JC]**

Text text text.



## 2.2 What is known about trends and attributable changes in extreme weather?

### Official Assessments:

**SREX:** The IPCC *Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* (2012)

**AR5:** The IPCC *Fifth Assessment Report Working Group 1* (2013)

**AR6:** The IPCC *Sixth Assessment Report Working Group 1* (2021)

**NCA17:** The *US Climate Science Special Report of the Fourth National Climate Assessment* (2017) Volume I Chapter 6.

### 2.2.1 Flooding

#### 2.2.1.1 IPCC and other official assessments [RM]

SREX (p. 176)

In the United States and Canada during the 20th century and in the early 21st century, **there is no compelling evidence for climate-driven changes in the magnitude or frequency of floods.**

AR5 (p. 214)

AR4 WGI Chapter 3 (Trenberth et al., 2007) did not assess changes in floods but AR4 WGII concluded that **there was not a general global trend in the incidence of floods** (Kundzewicz et al., 2007). SREX went further to suggest that there was low agreement and thus *low confidence* at the global scale regarding changes in the magnitude or frequency of floods or even the sign of changes.

AR5 WGII assesses floods in regional detail accounting for the fact that trends in floods are strongly influenced by changes in river management (see also Section 2.5.2). Although the most evident flood trends appear to be in northern high latitudes, where observed warming trends have been largest, in some regions no evidence of a trend in extreme flooding has been found, for example, over Russia based on daily river discharge (Shiklomanov et al., 2007). Other studies for Europe (Hannaford and Marsh, 2008; Renard et al., 2008; Petrow and Merz, 2009; Stahl et al., 2010) and Asia (Jiang et al., 2008; Delgado et al., 2010) show evidence for upward, downward or no trend in the magnitude and frequency of floods, so that there is currently no clear and widespread evidence for observed changes in flooding except for the earlier spring flow in snow-dominated regions (Seneviratne et al., 2012).

In summary, **there continues to be a lack of evidence and thus *low confidence* regarding the sign of trend in the magnitude and/or frequency of floods on a global scale.**

AR6 (Ch 11 p. 1568)

The SREX (Seneviratne et al., 2012) assessed *low confidence* for observed changes in the magnitude or frequency of floods at the global scale. This assessment was confirmed by the AR5 report (Hartmann et al., 2013). The SR15 (Hoegh-Guldberg et al., 2018) found increases in flood frequency and extreme streamflow in some regions, but decreases in other regions. **While the number of studies on flood trends has increased since the AR5 report, and there were also new analyses after the release of SR15 (Berghuijs et al., 2017; Blöschl et al., 2019; Gudmundsson et al., 2019), hydrological literature on**

**observed flood changes is heterogeneous, focusing at regional and sub-regional basin scales, making it difficult to synthesise at the global and sometimes regional scales.**

In summary, the seasonality of floods has changed in cold regions where snowmelt dominates the flow regime in response to warming (*high confidence*). **Confidence about peak flow trends over past decades on the global scale is low, but there are regions experiencing increases**, including parts of Asia, southern South America, the northeast USA, northwestern Europe, and the Amazon, **and regions experiencing decreases**, including parts of the Mediterranean, Australia, Africa, and the southwestern USA.

US NCA17 pp. 240-41:

“The IPCC AR5 did not attribute changes in flooding to anthropogenic influence nor report detectable changes in flooding magnitude, duration, or frequency. Trends in extreme high values of streamflow are mixed across the United States. Analysis of 200 U.S. stream gauges indicates areas of both increasing and decreasing flooding magnitude but does not provide robust evidence that these trends are attributable to human influences...

The complex mix of processes complicates the formal attribution of observed flooding trends to anthropogenic climate change and suggests that additional scientific rigor is needed in flood attribution studies. As noted above, precipitation increases have been found to strongly influence changes in flood statistics. However, in U.S. regions, **no formal attribution of precipitation changes to anthropogenic forcing has been made so far, so indirect attribution of flooding changes is not possible. Hence, no formal attribution of observed flooding changes to anthropogenic forcing has been claimed.**”

#### 2.2.1.2 Other scientific sources [RS]

Text text text.

## 2.2.2 Heatwaves

### 2.2.2.1 IPCC and other official assessments [RM]

AR5 (p. 212 WG1)

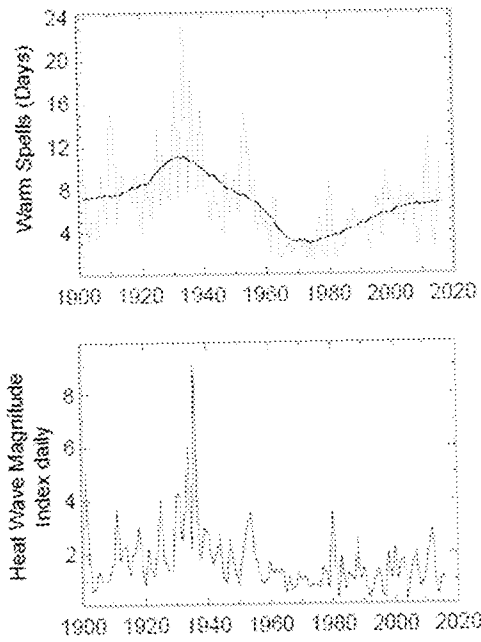
Table 2.13 shows that there has been a *likely* increasing trend in the frequency of heatwaves since the middle of the 20th century in Europe and Australia and across much of Asia where there are sufficient data. However, confidence on a global scale is *medium* owing to lack of studies over Africa and South America but also in part owing to differences in trends depending on how heatwaves are defined (Perkins et al., 2012). Using monthly means as a proxy for heatwaves Coumou et al. (2013) and Hansen et al. (2012) indicate that record-breaking temperatures in recent decades substantially exceed what would be expected by chance but caution is required when making inferences between these studies and those that deal with multi-day events and/ or use more complex definitions for heatwave events. **There is also evidence in some regions that periods prior to the 1950s had more heatwaves (e.g., over the USA, the decade of the 1930s stands out and is also associated with extreme drought conditions** (Peterson et al., 2013) whereas conversely in other regions heatwave trends may have been underestimated owing to poor quality and/or consistency of data (e.g., Della-Marta et al. (2007a) over Western Europe; Kuglitsch et al. (2009, 2010) over the Mediterranean). Recent available studies also suggest that the number of cold spells has reduced significantly since the 1950s (Donat et al., 2013a, 2013c).

In summary, new analyses continue to support the AR4 and SREX conclusions that since about 1950 it is *very likely* that the numbers of cold days and nights have decreased and the numbers of warm days and nights have increased overall on the global scale, that is, for land areas with sufficient data. It is *likely* that such changes have also occurred across most of North America, Europe, Asia and Australia.

NCA17 (pp. 190-191)

Changes in warm extremes are more nuanced than changes in cold extremes. For instance, **the warmest daily temperature of the year increased in some parts of the West over the past century (Figure 6.3), but there were decreases in almost all locations east of the Rocky Mountains. In fact, all eastern regions experienced a net decrease** (Table 6.2), most notably the Midwest (about 2.2°F [1.2°C]) and the Southeast (roughly 1.5°F [0.8°C]). The decreases in the eastern half of [the] Nation, particularly in the Great Plains, are mainly tied to the unprecedented summer heat of the 1930s Dust Bowl era, which was exacerbated by land-surface feedbacks driven by springtime precipitation deficits and land mismanagement. However, anthropogenic aerosol forcing may also have reduced summer temperatures in the Northeast and Southeast from the early 1950s to the mid-1970s, and agricultural intensification may have suppressed the hottest extremes in the Midwest.

Since the mid-1960s, there has been only a very slight increase in the warmest daily temperature of the year (amidst large interannual variability). **Heat waves (6-day periods with a maximum temperature above the 90th percentile for 1961–1990) increased in frequency until the mid-1930s, became considerably less common through the mid-1960s, and increased in frequency again thereafter (Figure 6.4). As with warm daily temperatures, heat wave magnitude reached a maximum in the 1930s.**



Source: Figure 6.4, USCCSR

AR6 (p. 1550)

In North America (Table 11.19), there is very robust evidence for a *very likely* increase in the intensity and frequency of hot extremes and decrease in the intensity and frequency of cold extremes for the whole continent, though there are substantial spatial and seasonal variations in the trends. Minimum temperatures display warming consistently across the continent, **while there are more contrasting trends in the annual maximum daily temperatures** in parts of the USA (Figure 11.9; Lee et al., 2014; van Oldenborgh et al., 2019; Dunn et al., 2020).

#### 2.2.2.2 Other scientific sources [RS]

Text text text.

### **2.2.3 Blizzards and extreme cold**

#### *2.2.3.1 IPCC and other official assessments [RM]*

Text text text.

#### *2.2.3.2 Other scientific sources [RS]*

Text text text.

## 2.2.4 Extreme precipitation

### 2.2.4.1 IPCC and other official assessments [RM]

SREX (p. 142/14448)

Recent studies have updated the assessment of the AR4, with more regional results now available (Table 3-2). Overall, this additional evidence confirms that **more locations and studies show an increase than a decrease in extreme precipitation, but that there are also wide regional and seasonal variations**, and trends in many regions are not statistically significant (Table 3-2)... Based on station data from Canada, the United States, and Mexico, Peterson et al. (2008a) reported that heavy precipitation has been increasing over 1950-2004, as well as the average amount of precipitation falling on days with precipitation.

AR5 (pp. 213-14)

In summary, further analyses continue to support the AR4 and SREX conclusions that **it is likely that since 1951 there have been statistically significant increases in the number of heavy precipitation events (e.g., above the 95th percentile) in more regions than there have been statistically significant decreases, but there are strong regional and subregional variations in the trends**. In particular, many regions present statistically non-significant or negative trends, and, where seasonal changes have been assessed, there are also variations between seasons (e.g., more consistent trends in winter than in summer in Europe). The overall most consistent trends towards heavier precipitation events are found in central North America (very likely increase) but assessment for Europe shows likely increases in more regions than decreases.

AR6 (p. 11-55)

In North America, there is robust evidence that the magnitude and intensity of extreme precipitation has *very likely* increased since the 1950s. Both [one-day maxima] and [5-day maxima] have significantly increased in North America during 1950-2018 (Sun et al., 2020, also Figure 11.13). There is, however, regional diversity. **In Canada, there is a lack of detectable trends in observed annual maximum daily (or shorter duration) precipitation (Shephard et al., 2014; Mekis et al., 2015; Vincent et al., 2018).**

NCA17 pp. 213-14:

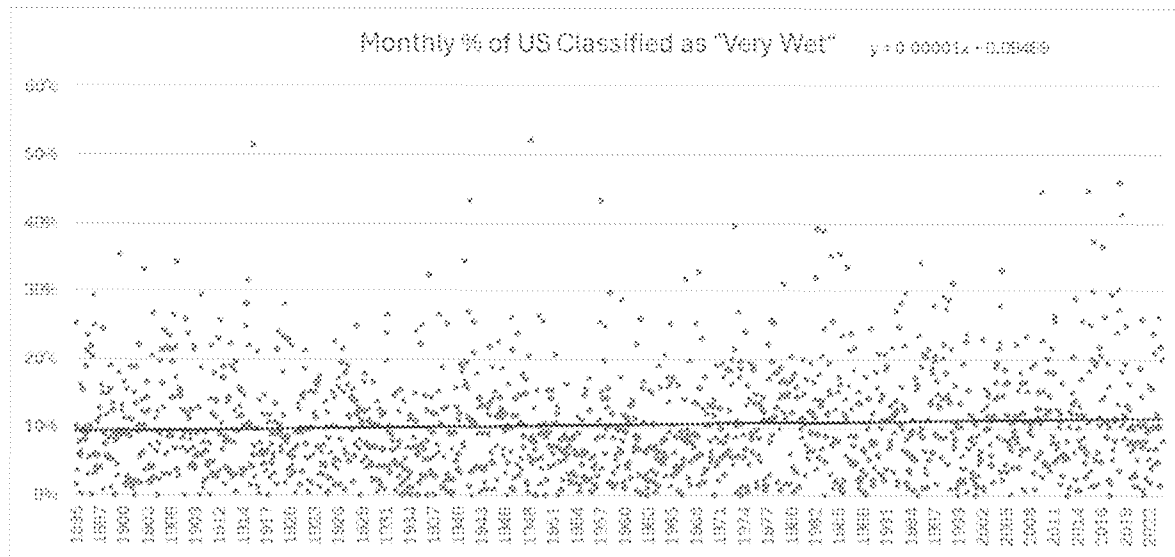
Detectability of trends (compared to internal variability) for a number of precipitation metrics over the continental United States has been examined; **however, trends identified for the U.S. regions have not been clearly attributed to anthropogenic forcing**. One study concluded that increasing precipitation trends in some north-central U.S. regions and the extreme annual anomalies there in 2013 were at least partly attributable to the combination of anthropogenic and natural forcing... **Based on current evidence, it is concluded that detectable but not attributable increases in mean precipitation have occurred over parts of the central United States**. Formal detection-attribution studies indicate a human contribution to extreme precipitation increases over the continental United States, but confidence is *low* based on those studies alone due to the short observational period, high natural variability, and model uncertainty.

In summary, based on available studies, it is concluded that for the continental United States there is *high confidence* in the detection of extreme precipitation increases, while there is *low confidence* in attributing the extreme precipitation changes purely to anthropogenic forcing.

#### 2.2.4.2 Other scientific sources [RS]

US long term data (NOAA) shows an insignificantly increasing tendency toward extreme wetness (+0.001% per year)

<https://www.ncei.noaa.gov/access/monitoring/uspa/wet-dry/0>



A deficiency of the NCA4 Report is that it focused only on the 1901-2016 interval. In many locations the trends are not consistent when examining other time intervals. McKittrick and Christy (2020)

- McKittrick, Ross R. and John Christy (2019) Assessing Changes in US Regional Precipitation on Multiple Time Scales *Journal of Hydrology* vol. 578 Nov 2019, <https://doi.org/10.1016/j.jhydrol.2019.124074>

took a sample of 20 US locations in the Southeast and Pacific coast. While measures of average and extreme precipitation increased slightly over the NCA4's 1901-2016 time interval, the available data in question go back to the mid-1800s and in many US locations the pre-1900 interval was marked by high levels of precipitation. McKittrick and Christy found that over the full data sample the trends were not necessarily uniform. Specifically the Southeast also showed a significant increase in the number of 1-day 99th percentile exceedances (the NCA4 metric for heavy rainfall events) over 1901-2016, but over the full record spanning 1872-2017 the trend is not significant, and in the post-1978 period the trend is actually slightly negative:

"Over the 1901-2017 interval upward trends in some measures of average and extreme precipitation appear, but they are not consistently significant and in the full records back to 1872 they largely disappear. They also disappear or reverse in the post-1978 portion of the data set, which is inconsistent with them being responses to enhanced greenhouse gas forcing. We conclude that natural variability is likely the dominant driver of historical changes in precipitation and hence drought dynamics in the US SE and PC.... Summing up, while trends can be identified on some time spans, on the longest samples the trends are not significant, nor are they significant over the shorter interval of enhanced greenhouse forcing, and the proxy data exhibit long term persistence. Taken together these findings are

consistent with the view that natural variability is likely the dominant factor in historical US precipitation changes through to the present time.”



## 2.2.5 Tornadoes and severe convective storms

### 2.2.5.1 IPCC and other official assessments [RM]

IPCC AR6 Sct. 11.7.3, p. 1594

Severe convective storms are convective systems that are associated with extreme phenomena such as tornadoes, hail, heavy precipitation (rain or snow), strong winds, and lightning.

The assessment of changes in severe convective storms in SREX (Chapter 3, Seneviratne et al., 2012) and AR5 (Chapter 12, Collins et al., 2013) is limited and focused mainly on tornadoes and hail storms. The SREX assessed that there is *low confidence* in observed trends in tornadoes and hail because of data inhomogeneities and inadequacies in monitoring systems. Subsequent literature assessed in the Climate Science Special Report (Kossin et al., 2017) led to the assessment of the observed tornado activity over the 2000s in the USA, with a decrease in the number of days per year with tornadoes and an increase in the number of tornadoes on these days (*medium confidence*). However, there is *low confidence* in past trends for hail and severe thunderstorm winds. Climate models consistently project environmental changes that would support an increase in the frequency and intensity of severe thunderstorms that combine tornadoes, hail, and winds (*high confidence*), but there is *low confidence* in the details of the projected increase.

Trends: p. 1595

In summary, because the definition of severe convective storms varies depending on the literature and the region, it is not straightforward to make a synthesizing view of observed trends in severe convective storms in different regions. In particular, observational trends in tornadoes, hail, and lightning associated with severe convective storms are not robustly detected due to insufficient coverage of the long-term observations. There is *medium confidence* that the mean annual number of tornadoes in the USA has remained relatively constant, but their variability of occurrence has increased since the 1970s, particularly over the 2000s, with a decrease in the number of days per year, and an increase in the number of tornadoes on these days (*high confidence*). Detected tornadoes have also increased in Europe, but the trend depends on the density of observations.

Attribution: p. 1596

It is extremely difficult to detect differences in time and space of severe convective storms (Kunkel et al., 2013). Although some ingredients that are favourable for severe thunderstorms have increased over the years, others have not; thus, overall, changes in the frequency of environments favourable for severe thunderstorms have not been statistically significant... For hailstorms, such as those that caused disasters in the USA in 2018, detection of the role of climate change in changing hail storms is more difficult, because hail storms are not, in general, directly simulated by convection-permitting models and not adequately represented by the environmental parameters of coarse-resolution GCMs (Mahoney, 2020).

In summary, it is extremely difficult to detect and attribute changes in severe convective storms. There is limited evidence that extreme precipitation associated with severe convective storms has increased in some cases.

#### *2.2.5.2 Other scientific sources [RS]*

Text text text.

## 2.2.6 Hurricanes and Tropical Cyclones

### 2.2.6.1 IPCC and other official assessments [RM]

SREX (p. 159):

**There have been no significant trends observed in global tropical cyclone frequency records, including over the present 40-year period of satellite observations** (e.g., Webster et al., 2005). Regional trends in tropical cyclone frequency have been identified in the North Atlantic, but the fidelity of these trends is debated (Holland and Webster, 2007; Landsea, 2007; Mann et al., 2007a). Different methods for estimating undercounts in the earlier part of the North Atlantic tropical cyclone record provide mixed conclusions (Chang and Guo, 2007; Mann et al., 2007b; Kunkel et al., 2008; Vecchi and Knutson, 2008). Regional trends have not been detected in other oceans (Chan and Xu, 2009; Kubota and Chan, 2009; Callaghan and Power, 2011). **It thus remains uncertain whether any observed increases in tropical cyclone frequency on time scales longer than about 40 years are robust,** after accounting for past changes in observing capabilities (Knutson et al., 2010).

AR5 (pp. 216-17):

**Current data sets indicate no significant observed trends in global tropical cyclone frequency** over the past century and it remains uncertain whether any reported long-term increases in tropical cyclone frequency are robust, after accounting for past changes in observing capabilities (Knutson et al., 2010). **No robust trends in annual numbers of tropical storms, hurricanes and major hurricanes counts have been identified** over the past 100 years in the North Atlantic basin. Measures of land-falling tropical cyclone frequency (Figure 2.34) are generally considered to be more reliable than counts of all storms which tend to be strongly influenced by those that are weak and/or short lived. Callaghan and Power (2011) find a statistically significant decrease in Eastern Australia land-falling tropical cyclones since the late 19th century although including 2010/2011 season data this trend becomes non-significant (i.e., a trend of zero lies just inside the 90% confidence interval). Significant trends are not found in other oceans on shorter time scales (Chan and Xu, 2009; Kubota and Chan, 2009; Mohapatra et al., 2011; Weinkle et al., 2012), although Grinsted et al. (2012) find a significant positive trend in eastern USA using tide-gauge data from 1923–2008 as a proxy for storm surges associated with land-falling hurricanes. Differences between tropical cyclone studies highlight the challenges that still lie ahead in assessing long-term trends.

In summary, this assessment does not revise the SREX conclusion of *low confidence* that any reported long-term (centennial) increases in tropical cyclone activity are robust, after accounting for past changes in observing capabilities. More recent assessments indicate that **it is unlikely that annual numbers of tropical storms, hurricanes and major hurricanes counts have increased over the past 100 years in the North Atlantic basin.** Evidence, however, is for a virtually certain increase in the frequency and intensity of the strongest tropical cyclones since the 1970s in that region.

AR6 (p. 1585)

**There is low confidence in most reported long-term (multidecadal to centennial) trends in TC frequency- or intensity-based metrics due to changes in the technology used to collect the best-track data.** This should not be interpreted as implying that no physical (real) trends exist, but rather as indicating that either the quality or the temporal

length of the data is not adequate to provide robust trend detection statements, particularly in the presence of multidecadal variability.

There are previous and ongoing efforts to homogenize the best-track data (Elsner et al., 2008; Kossin et al., 2013, 2020; Choy et al., 2015; Landsea, 2015; Emanuel et al., 2018) and there is substantial literature that finds positive trends in intensity-related metrics in the best-track during the “satellite period”, which is generally limited to the past ~40 years (Kang and Elsner, 2012; Kishtawal et al., 2012; Kossin et al., 2013, 2020; Mei and Xie, 2016; Zhao et al., 2018; Tauvale and Tsuboki, 2019). **When best-track trends are tested using homogenized data, the intensity trends generally remain positive, but are smaller in amplitude** (Kossin et al., 2013; Holland and Bruyère, 2014). **Kossin et al. (2020) extended the homogenized TC intensity record to the period 1979–2017 and identified significant global increases in major TC exceedance probability of about 6% per decade.** In addition to trends in TC intensity, there is evidence that TC intensification rates and the frequency of rapid intensification events have increased within the satellite era (Kishtawal et al. 2012; Balaguru et al., 2018; Bhatia et al., 2018). The increase in intensification rates is found in the best-track as well as the homogenized intensity data.

**A subset of the best-track data corresponding to hurricanes that have directly impacted the United States since 1900 is considered to be reliable, and shows no trend in the frequency of U.S. landfall events (Knutson et al., 2019).**

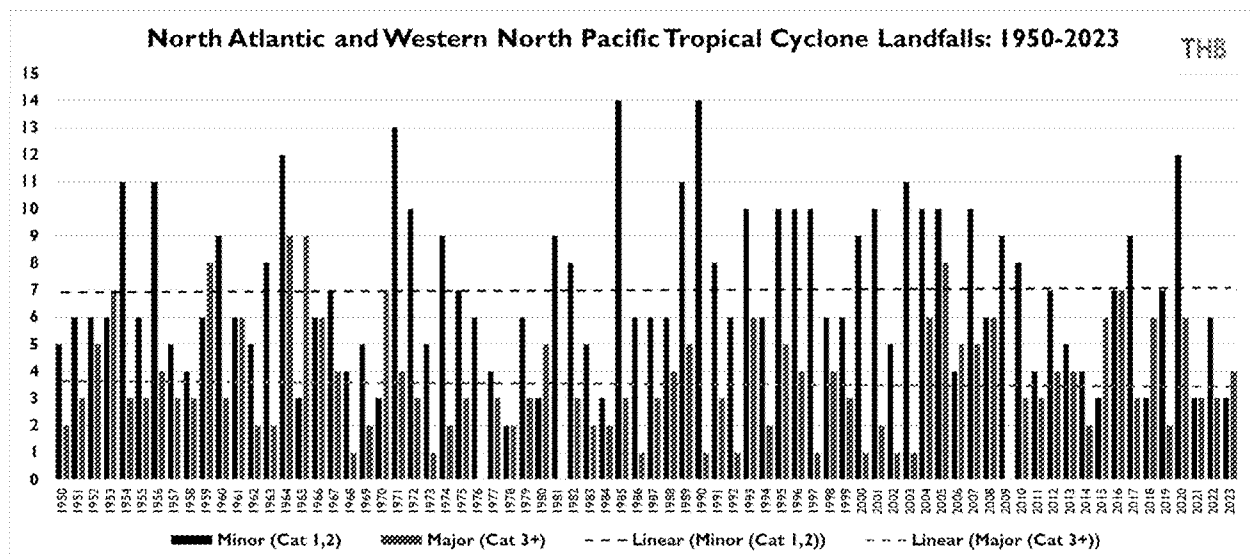
**Underlined** text referenced a study (Kossin et al. 2020) that later retracted a portion of its findings.

The paper was

- Kossin, J et al. (2020) Global increase in major tropical cyclone exceedance probability over the past four decades *Proc Nat Acad Sci* 117 (22) 11975-11980  
<https://www.pnas.org/doi/10.1073/pnas.1920849117>

The authors assembled a data set on global TC incidence spanning 1979 to 2017. They claimed that the global fraction of TCs reaching major status (Cat 3—5) rose from 27% in the 1979-1997 interval to 31% in the 1998-2017 interval and the difference was statistically significant. Closer examination of their results however (Table 1) showed a significant increase was only observed in the North Atlantic (18% to 34%) whereas in every other basin (Eastern Pacific, Western Pacific, North Indian, South Indian, South Pacific) the differences were not statistically significant. They estimated that the global increase in the probability of a hurricane becoming major rose by an average of 6% per decade.

The next problem with their claim is that, unlike other basins, hurricane strength records for the North Atlantic and the Western Pacific go back to 1950 and the whole record does not show an increase in either total or major TCs:



<https://rogerpielkejr.substack.com/p/global-tropical-cyclones>

After the Kossin paper was published a reader named Greg Kent examined the data and found that Kossin et al. had made elementary tabulation errors which needed to be corrected. They issued a Correction (<https://www.pnas.org/doi/10.1073/pnas.2021573117>). The main one was that the global probability of observing a major TC was now 34% in the 1979 to 1997 interval rising to 37% in the later period and the evidence for statistical significance was now weaker, although the authors claimed that the correction did not affect their conclusions.

Kent also showed that within the Kossin et al. data set, only Category 3 hurricanes showed an increase in occurrent probability: Cat4 storms were unchanged and Cat5 storms became *less* likely.

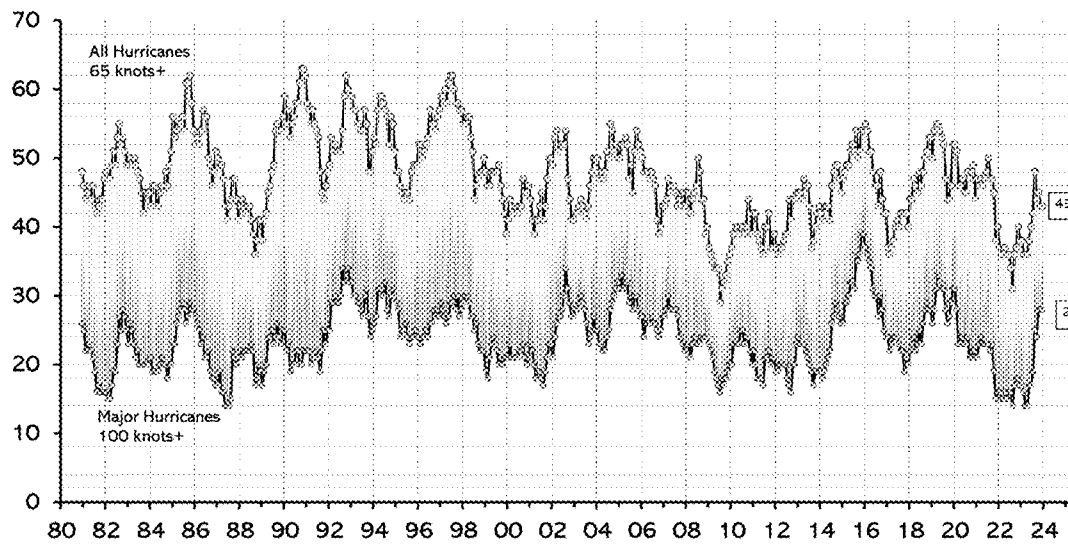
### 2.2.6.2 Other scientific sources [RS]

the total number of hurricanes is not increasing and in many basins is decreasing. Consequently even if the fraction that becomes major goes up, the total number of major storms doesn't necessarily go up as well. As shown in the Climate Atlas data set maintained by Dr. Ryan Maue neither total hurricanes nor major ones have become more common since 1980, indeed both have trended down:

## Global Major Hurricane Frequency -- 12 month running sums -- @RyanMaue

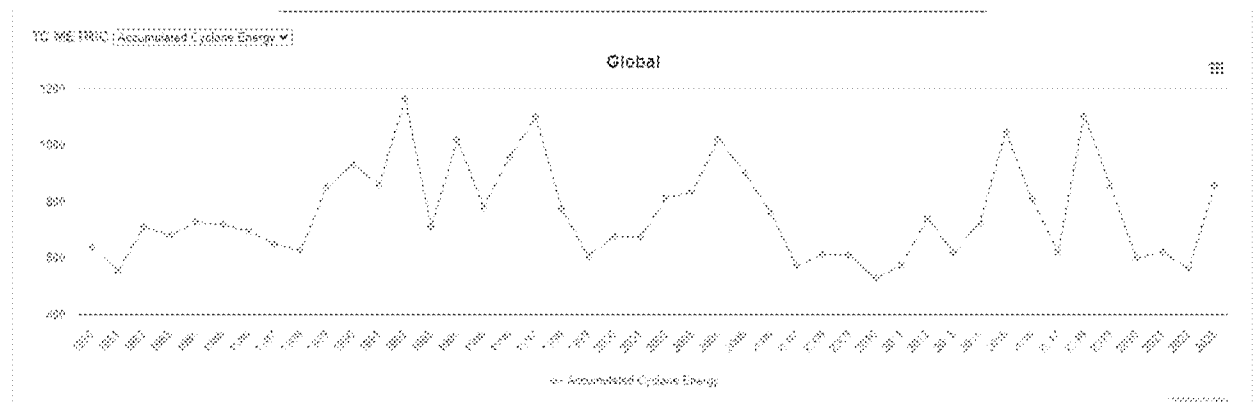
Updated December 31, 2023

Last 30-years: 45.7 H | 24.4 M



<https://climatlas.com/tropical/>

A metric that combines the number and frequency of TCs is the Accumulated Cyclone Energy. It is computed by Phil Klotzbach at Colorado State University:



<https://tropical.atmos.colostate.edu/Realtime/index.php?arch&loc=global>

As is clear, it is also not increasing and since 1990 has trended down slightly.

Climate models show declining hurricane formation rates in a warming climate:

- Chand et al. (2022) Declining tropical cyclone frequency under global warming. *Nature* 12 655—661. <https://www.nature.com/articles/s41558-022-01388-4>

“Here, using a reconstructed long-term proxy of annual TC numbers together with high-resolution climate model experiments, we show robust declining trends in the annual number of TCs at global and regional scales during the twentieth century.”

Climate models also project fewer TCs under future global warming, and even though they increase in strength, the annual averages of rainfall maxima decline:

- Stansfield et al. (2020) "Changes in Precipitation From North Atlantic Tropical Cyclones Under RCP Scenarios in the Variable-Resolution Community Atmosphere Model" *Geophys. Res. Letters*  
<https://agupubs.onlinelibrary.wiley.com/doi/pdfdirect/10.1029/2019GL086930>

Abstract: Decreasing climate models' grid spacing improves the representation of tropical cyclones at decadal time scales. In this study, a variable-resolution (VR) version of the Community Atmosphere Model 5 (CAM5-VR) is utilized to study North Atlantic tropical cyclone climatology in ensemble historical climate simulations and under two Representative Concentration Pathway (RCP) projections (RCP4.5 and RCP8.5). **Basin-wide tropical cyclone counts decrease** in the RCP simulations, although landfalling storm counts do not show as straightforward of a pattern, especially when focusing on regional changes. Lifetime maximum intensity metrics suggest that **tropical cyclones increase in strength** in the RCP ensembles. **However, despite increases in tropical cyclone-related precipitation rates and the amount of precipitation produced per storm with warming, the annual average Rx5day [annual maximum 5-day precipitation total] from tropical cyclones over the eastern United States decreases due to less landfalling storms.** This work is part of a continued effort to quantify how tropical cyclone-induced hazards may change in future climates.

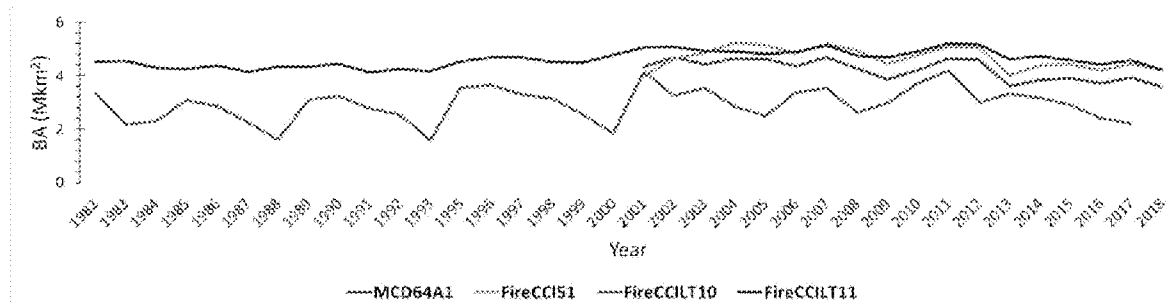
## 2.2.7 Wildfires

### 2.2.7.1 IPCC and other official assessments [RM]

The IPCC has not provided an assessment of wildfires.

### 2.2.7.2 Other scientific sources [RS]

Global wildfire measured by European Space Agency: 1982-2018; peaked in early 00's

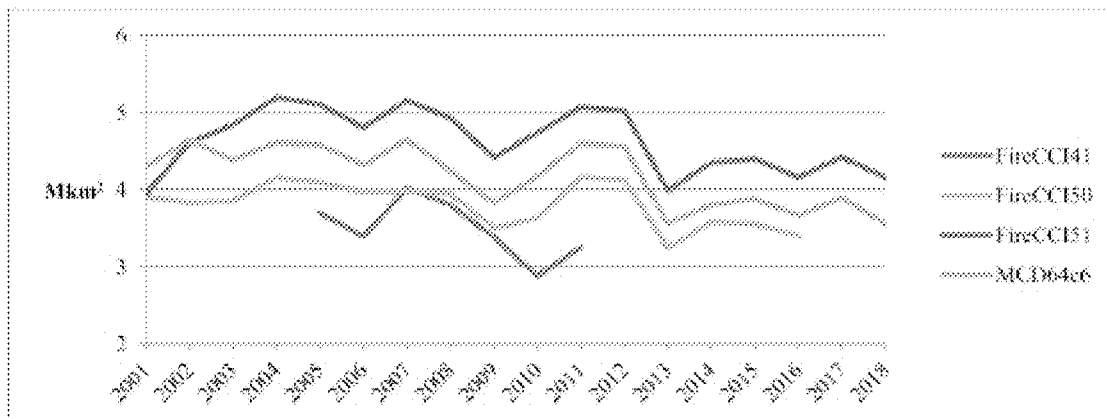


Copied from Oton et al. 2021

<https://www.sciencedirect.com/science/article/pii/S030324342100180X?via%3Dihub>

The different coloured lines represent different data products based on satellites and algorithms used.

Note that post-2001 ESA data products show downward trends:



Copied from Lizundia-Loiola et al. (2021)

<https://www.sciencedirect.com/science/article/pii/S0034425719305127?via%3Dihub>

Also see Doerr SH and Santin C. (2016) Global trends in wildfire and its impacts: perceptions versus realities in a changing world. *Philosophical Transactions of the Royal Society. B* 371: 20150345. <http://dx.doi.org/10.1098/rstb.2015.0345>

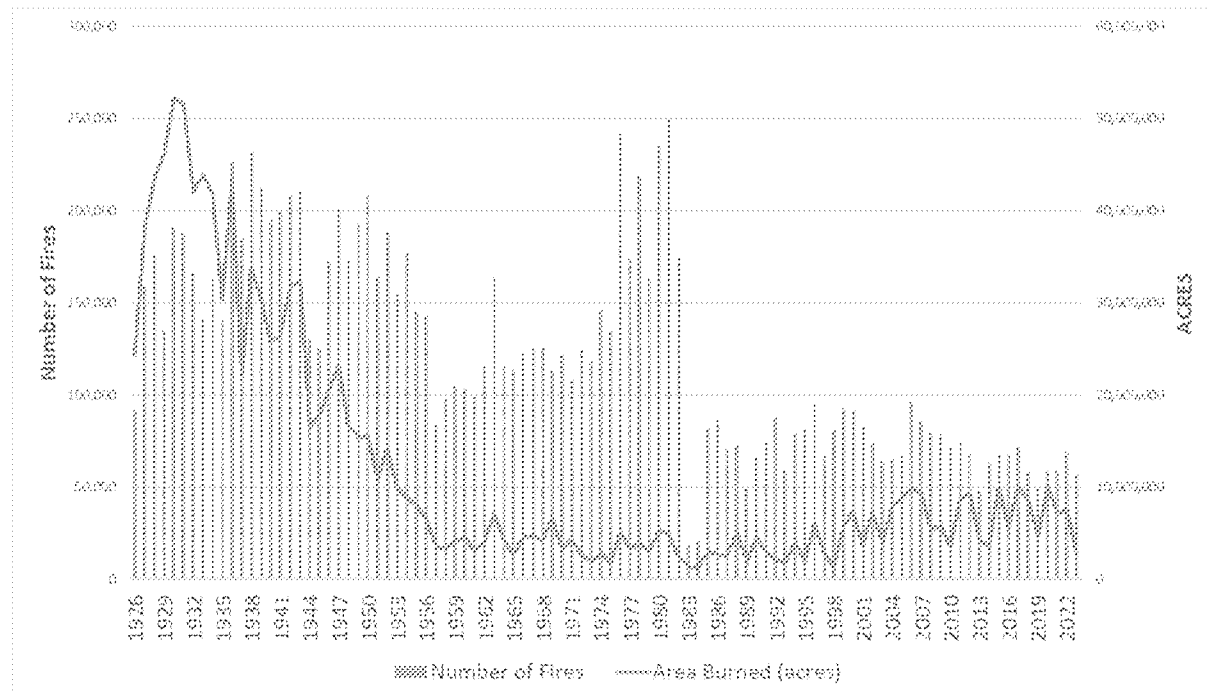
Abstract:

Wildfire has been an important process affecting the Earth's surface and atmosphere for over 350 million years and human societies have coexisted with fire since their emergence.



Yet many consider wildfire as an accelerating problem, with widely held perceptions both in the media and scientific papers of increasing fire occurrence, severity and resulting losses. However, important exceptions aside, the quantitative evidence available does not support these perceived overall trends. Instead, global area burned appears to have overall declined over past decades, and there is increasing evidence that there is less fire in the global landscape today than centuries ago. Regarding fire severity, limited data are available. For the western USA, they indicate little change overall, and also that area burned at high severity has overall declined compared to pre-European settlement. Direct fatalities from fire and economic losses also show no clear trends over the past three decades. Trends in indirect impacts, such as health problems from smoke or disruption to social functioning, remain insufficiently quantified to be examined. Global predictions for increased fire under a warming climate highlight the already urgent need for a more sustainable coexistence with fire. The data evaluation presented here aims to contribute to this by reducing misconceptions and facilitating a more informed understanding of the realities of global fire.

US data from 1926 to 2023 are as follows:



Source:

[https://web.archive.org/web/20200212033452/https://www.nifc.gov/fireInfo/fireInfo\\_stats\\_totalFires.html](https://web.archive.org/web/20200212033452/https://www.nifc.gov/fireInfo/fireInfo_stats_totalFires.html) (pre-2017)

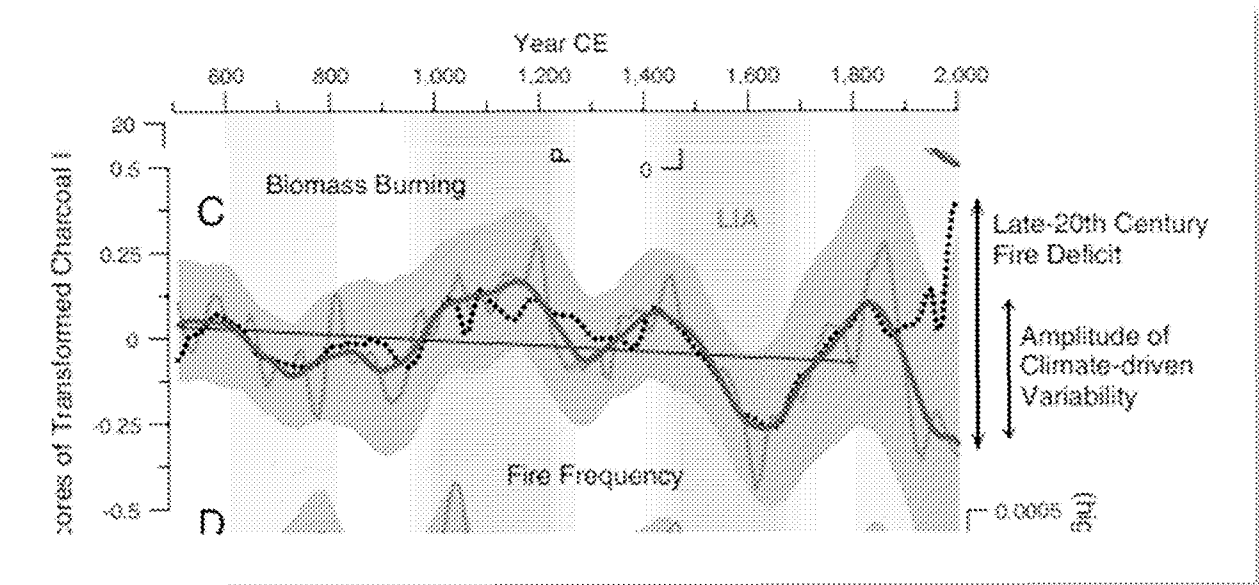
<https://www.nifc.gov/fire-information/statistics/wildfires> (2018-2023)

Note the NIFC has removed the pre-1960 data from its current website.

Even just focusing on the post-1985 interval the number of fires is not increasing. The area burned did increase but only until about 2007.

Marlon et al. (2012 "Long-term perspective on wildfires in the western USA" *Proc Nat Acad Sci*.) used sedimentary charcoal layers to reconstruct fire history of western US back 1400 years. They

also fit a model to predict expected fire activity as a function of climatic conditions. The results are summarized in the Figure below (from Figure 2 in their paper).



In their figure the red line shows the smoothed charcoal record and the black dotted line shows the predicted charcoal record based on the statistical model. The gap at the end is the current Fire Deficit, covering the 20<sup>th</sup> century. In other words, however much fire was observed in the 20<sup>th</sup> century it was far less than what would have been observed in previous centuries based on the climatic conditions. The authors comment:

The fire deficit identified here might appear to contrast with observations of recent increases in western U.S. fire activity and also to the well established fire-climate interactions documented across the region. These apparent differences can be reconciled by explicit consideration of the time scale of the variations. We show that mean or baseline levels of biomass burned and fire frequency decreased substantially during the past century compared with previous centuries; **the recent increase in “fire activity” (i.e., large-wildfire occurrence) is therefore occurring during a period of unusually low levels of biomass burning.** ... During the past two centuries, however, centennial-scale changes in biomass burned and fire frequency however, are decoupled from climate due to the strong human influences on forests and fires. (p. E541)

Recent study on North American wildfire deficit: Parks et al. (2025)  
<https://www.nature.com/articles/s41467-025-56333-8>

## 2.2.8 Droughts

### 2.2.8.1 IPCC and other official assessments [RM]

#### US NCA17 REPORT

Quick summary: The paleoclimate record provides clear evidence of extensive natural drought activity. Today's droughts are not out of the bounds of natural variability.

#### Chapter 8. Full citation:

Wehner, M.F., J.R. Arnold, T. Knutson, K.E. Kunkel, and A.N. LeGrande, 2017: Droughts, floods, and wildfires. In: *Climate Science Special Report: Fourth National Climate Assessment, Volume I* [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 231-256 doi: 10.7930/JOCJ8BNN.

p. 231:

Recent droughts and associated heat waves have reached record intensity in some regions of the United States; however, by geographical scale and duration, the Dust Bowl era of the 1930s remains the benchmark drought and extreme heat event in the historical record (very high confidence). **While by some measures drought has decreased over much of the continental United States in association with long-term increases in precipitation, neither the precipitation increases nor inferred drought decreases have been confidently attributed to anthropogenic forcing.**

The human effect on recent major U.S. droughts is complicated. Little evidence is found for a human influence on observed precipitation deficits, but much evidence is found for a human influence on surface soil moisture deficits due to increased evapotranspiration caused by higher temperatures. (*High confidence*)

p. 233 (Note Fig 7.1 shows past increases in precipitation while Figure 7.5 shows projected future changes by season)

Drought is, of course, directly connected to seasonal precipitation totals. Figure 7.1 shows detectable observed recent changes in seasonal precipitation. In fact, the increases in observed summer and fall precipitation are at odds with the projections in Figure 7.5. **As a consequence of this increased precipitation, drought statistics over the entire CONUS have declined.**

#### Past IPCC Reports do not support global attribution claims:

SREX (p. 170)

**From a paleoclimate perspective recent droughts are not unprecedented, with severe 'megadroughts' reported in the paleoclimatic record for Europe, North America, and Australia** (Jansen et al., 2007). Recent studies extend this observation to African and Indian droughts (Sinha et al., 2007; Shanahan et al., 2009): much more severe and longer droughts occurred in the past centuries with widespread ecological, political, and socioeconomic consequences. Overall, these studies confirm that in the last millennium several extreme droughts have occurred (Breda and Badeau, 2008; Kallis, 2008; Büntgen et al., 2010).

**In North America, there is *medium confidence* that there has been an overall slight tendency toward less dryness** (wetting trend with more soil moisture and runoff; Table 3-

2), although analyses for some subregions also indicate tendencies toward increasing dryness. This assessment is based on several lines of evidence, including simulations with different hydrological models as well as PDSI and CDD estimates (Alexander et al., 2006; Andreadis and Lettenmaier, 2006; van der Schrier et al., 2006a; Kunkel et al., 2008; Sheffield and Wood, 2008a; Dai, 2011).

**The most severe droughts in the 20th century have occurred in the 1930s and 1950s,** where the 1930s Dust Bowl was most intense and the 1950s drought most persistent (Andreadis et al., 2005) in the United States, while in Mexico the 1950s and late 1990s were the driest periods. Recent regional trends toward more severe drought conditions were identified over southern and western Canada, Alaska, and Mexico, with subregional exceptions (Dai, 2011).

SREX (p. 172)

**Overall, though new studies have furthered the understanding of the mechanisms leading to drought, there is still relatively limited evidence to provide an attribution of observed changes,** in particular given the issues associated with the availability of observational data (Section 3.2.1) and the definition and computation of drought indicators (Box 3-3). This latter point was mostly identified in post-AR4 studies (Box 3-3). Moreover, regions where consistent increases in drought are identified (see ‘Observed Changes’) are only partly consistent with those where projections indicate an enhancement of drought conditions in coming decades (see next paragraphs). We thus assess that there is *medium confidence* (see also Section 3.1.5) that anthropogenic influence has contributed to some changes in the drought patterns observed in the second half of the 20<sup>th</sup> century, based on its attributed impact on precipitation and temperature changes (though temperature can only be indirectly related to drought trends; see Box 3-3). However **there is low confidence in the attribution of changes in droughts at the level of individual regions.**

AR5 (pp. 214-215)

Based on evidence since AR4, SREX concluded that there were not enough direct observations of dryness to suggest high confidence in observed trends globally, although there was *medium confidence* that since the 1950s some regions of the world have experienced more intense and longer droughts. The differences between AR4 and SREX are due primarily to analyses post-AR4, differences in how both assessments considered drought and updated IPCC uncertainty guidance.

Because drought is a complex variable and can at best be incompletely represented by commonly used drought indices, discrepancies in the interpretation of changes can result. For example, Sheffield and Wood (2008) found decreasing trends in the duration, intensity and severity of drought globally. Conversely, Dai (2011a,b) found a general global increase in drought, although with substantial regional variation and individual events dominating trend signatures in some regions (e.g., the 1970s prolonged Sahel drought and the 1930s drought in the USA and Canadian Prairies). Studies subsequent to these continue to provide somewhat different conclusions on trends in global droughts and/or dryness since the middle of the 20th century (Sheffield et al., 2012; Dai, 2013; Donat et al., 2013c; van der Schrier et al., 2013).

**In summary, the current assessment concludes that there is not enough evidence at present to suggest more than low confidence in a global-scale observed trend in drought or dryness (lack of rainfall) since the middle of the 20th century, owing to**

lack of direct observations, geographical inconsistencies in the trends, and dependencies of inferred trends on the index choice. Based on updated studies, AR4 conclusions regarding global increasing trends in drought since the 1970s were probably overstated. However, it is *likely* that the frequency and intensity of drought has increased in the Mediterranean and West Africa and decreased in central North America and north-west Australia since 1950.

AR6 (Drought, Observed trends, Section 11.6.2, pp. 1573-75)

p. 1573

Strong precipitation deficits have been recorded in recent decades in the Amazon (2005, 2010), south-western China (2009–2010), south-western North America (2011–2014), Australia (1997–2009), California (2014), the middle East (2012–2016), Chile (2010–2015), the Great Horn of Africa (2011), among others (van Dijk et al., 2013; Mann and Gleick, 2015; Rowell et al., 2015; Marengo and Espinoza, 2016; Dai and Zhao, 2017; Garreaud et al., 2017, 2020; Marengo et al., 2017; Brito et al., 2018; Cook et al., 2018). **Global studies generally show no significant trends in SPI time series** (Orlowsky and Seneviratne, 2013; Spinoni et al., 2014), **and in derived drought frequency and severity data** (Spinoni et al., 2019), with very few regional exceptions (Section 11.9 and Figure 11.17).

p. 1574

For AR6 regions, several studies suggest an increase in the frequency and areal extent of soil moisture deficits, with examples in East Asia (Cheng et al., 2015; Y. Qin et al., 2015; Jia et al., 2018), Western and Central Europe (Trnka et al., 2015b), and the Mediterranean (Hanel et al., 2018; Moravec et al., 2019; Markonis et al., 2021). **Nonetheless, some analyses also show no long-term trends in soil drying in some AR6 regions – for example, in Eastern North America (Park Williams et al., 2017) and Central North America** (Seager et al., 2019), as well as in North Eastern Africa (Kew et al., 2021).

There is evidence based on streamflow records of increased hydrological droughts in East Asia (D. Zhang et al., 2018) and southern Africa (Gudmundsson et al., 2019). **In areas of Western and Central Europe and Northern Europe, there is no evidence of changes in the severity of hydrological droughts since 1950** based on flow reconstructions (Caillouet et al., 2017; Barker et al., 2019) and observations (Vicente-Serrano et al., 2019). **In North America, depending on the methods, datasets and study periods, there are differences between studies that suggest an increase (Shukla et al., 2015; Udall and Overpeck, 2017) versus a decrease in hydrological drought frequency (Mo and Lettenmaier, 2018), but in general there is strong spatial variability** (Poshtiri and Pal, 2016). Streamflow observation reference networks of near-natural catchments have also been used to isolate the effect of climate trends on hydrological drought trends in a few regions, but these show limited trends in Northern Europe and Western and Central Europe (Stahl et al., 2010; Bard et al., 2015; Harrigan et al., 2018), North America (Dudley et al., 2020) and most of Australia, with the exception of Eastern and Southern Australia (X.S. Zhang et al., 2016).

p. 1575

**Few AR6 regions show observed increases in meteorological drought** (Section 11.9), mostly in Africa and South America (NES: *high confidence*; WAF, CAF, ESAF, SAM, SWS, SSA, SAS: *medium confidence*); a few others show a decrease (WSB, ESB, NAU, CAU, NEU, CNA: *medium confidence*). There are stronger signals indicating observed increases in agricultural

and ecological drought (Section 11.9), which highlights the role of increased [evapotranspiration], driven by increased [Atmospheric Evaporative Demand], for these trends (Sections 11.6.2.3, 11.6.2.5). Past increases in agricultural and ecological droughts are found on all continents and several regions (WAF, CAF, WSAF, ESAF, WCA, ECA, EAS, SAU, MED, WCE, NES: *medium confidence*), while decreases are found only in one AR6 region (NAU: *medium confidence*). The more limited availability of datasets makes it more difficult to assess historical trends in hydrological drought at regional scale (Section 11.9). Increasing (MED: *high confidence*; WAF, EAS, SAU: *medium confidence*) and decreasing (NEU, SES: *medium confidence*) trends in hydrological droughts have only been observed in a few regions.

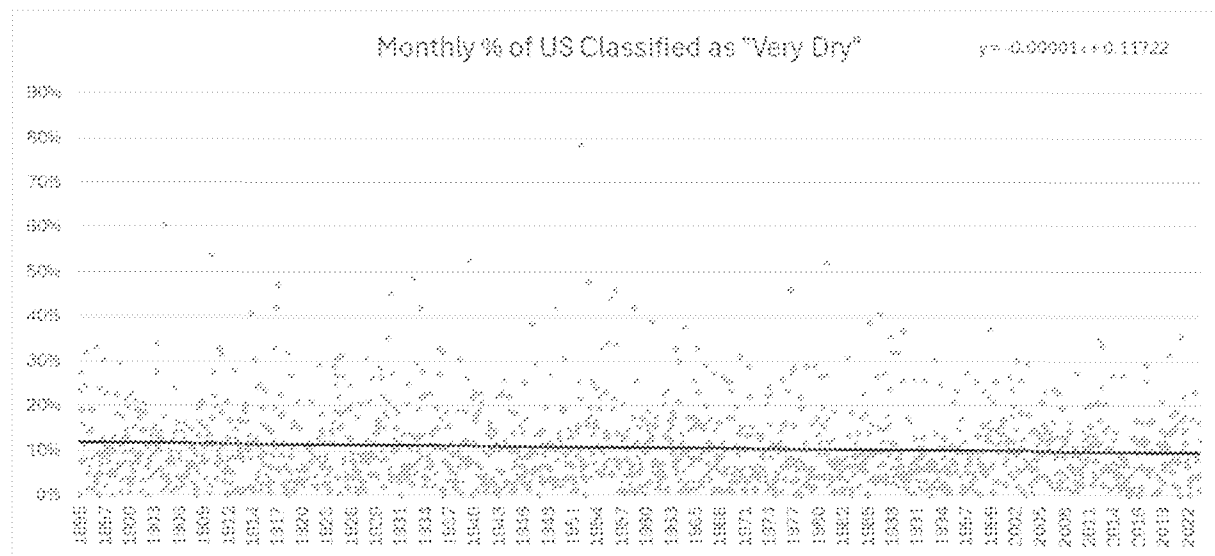
#### AR6 on Attribution (p. 1577)

There are only two AR6 regions in which there is at least *medium confidence* that human-induced climate change has contributed to changes in meteorological droughts (Section 11.9). In South-western South America (SSW), there is *medium confidence* that human-induced climate change has contributed to an increase in meteorological droughts (Boisier et al., 2016; Garreaud et al., 2020), while in Northern Europe (NEU), there is *medium confidence* that it has contributed to a decrease in meteorological droughts (Gudmundsson and Seneviratne, 2016) (Section 11.9). **In other AR6 regions, there is inconclusive evidence in the attribution of long-term trends, but a human contribution to single meteorological events or subregional trends has been identified in some instances... In North America, the human influence on precipitation deficits is complex (Wehner et al., 2017), with low confidence in the attribution of long-term changes in meteorological drought in AR6 regions.**

#### 2.2.8.2 Other scientific sources [RS]

US long term data (NOAA) shows insignificantly declining tendency toward extreme dryness (-0.001% per year)

<https://www.ncei.noaa.gov/access/monitoring/uspa/wet-dry/0>



Kogan et al. (2020) "Near 40-year drought trend during 1981-2019 earth warming and food security" *Geomatics, Natural Hazards and Risk* Vol 11(1)

Argues that global drought data as measured by satellite do not support a connection to climate warming.

"This paper develops and investigates satellite-derived 38-year high-resolution drought data sets and evaluate their trends, during 1981-2018. Drought was estimated using satellite-based Vegetation Health (VH) method. The results indicated that for the entire globe, hemispheres and the main grain-producing countries (China, USA and India) drought has not intensified and expanded during 38-year, while the global temperature anomaly has strongly increased. Since drought has not intensified and expanded during strong global warming, food security in the next few years is likely to remain at the level of the most recent decade."

"In spite of doubling global [temperature], neither drought area nor intensity have increased, which has been erroneously expected."

"Following the presented 38-year satellite data, it is possible to state firmly that global and main grain countries' drought area and intensity trends have not been following global climate warming since 1980's."

## **2.3 IPCC Assessment of signal emergence in extreme weather types [RS]**

(IPCC WG1 Table 12.12)



## **2.4 Changes in sea level [RS]**

Text text text

## **2.5 Extreme weather event attribution [RM]**

Text text text.

## **2.6 Summary**

Text text text.

### **3 Other impacts of climate change**

#### **3.1 Climate change and global greening [RS]**

Text text text.

### **3.2 Climate change and US agriculture [RM]**

Text text text.

### **3.3 Climate change and economic growth [RM]**

Text text text.

### **3.4 Climate change and US ozone levels [RS]**

Text text text.

### **3.5 Climate change and vector-borne diseases [RS]**

Text text text.



### **3.6 Estimates of the Social Cost of Carbon [RM]**

Text text text.

### **3.7 Summary**

Text text text.

## **4 The role of US motor vehicle transportation in the climate system**

### **4.1 US CO<sub>2</sub> emissions by sector [RS]**

Text text text.

## **4.2 US vehicle emissions as a fraction of global CO<sub>2</sub> emissions [RS]**

Text text text.

### **4.3 Estimating the effect on the global climate system of variations in US tailpipe CO<sub>2</sub> emissions [RS]**

Text text text.

#### **4.4 Summary**

Text text text.

## **5 Conclusions**

### **5.1 Conclusions as to whether US weather is materially more dangerous than in the past**

Text text text.

## **5.2 Conclusions as to whether GHGs have a well-understood role in making the weather more dangerous**

Text text text.



### **5.3 Conclusions as to the role of US vehicle emissions in global climate change**

Text text text.

## **5.4 Final comments and conclusions**

Text text text.

---

**From:** Roy Spencer <roywspencer@hotmail.com>  
**Sent:** Sunday, April 13, 2025 6:01 AM  
**To:** Ross McKittrick; Steven Koonin; John Christy  
**Subject:** Re: Saturday Apr 12 draft

1. Will we be working from a common document accessible to all simultaneously? In the past I've run into issues with this, but I'm sure people have found a way to make it work.... If we are each responsible for separate sections, this should be cleaner without everyone editing over each others' words.
2. How should references be handled? (Word footnotes, citations, or just Author [date] manually sorted at the end? Do we worry about a common format for references?

-Roy

---

**From:** Ross McKittrick <ross.mckittrick@gmail.com>  
**Sent:** Saturday, April 12, 2025 9:13 AM  
**To:** Steven Koonin <steven.koonin@gmail.com>; Roy W. Spencer <roywspencer@hotmail.com>; John Christy <climateman60@gmail.com>  
**Subject:** Saturday Apr 12 draft

I've taken Steve's suggested outline and added some sections based on another summary document someone sent me earlier. In the attached Word document the section titles are entered using heading formats so a Table of Contents can be automatically generated as shown. In other words don't edit the Table of Contents, if you want to rename a section edit the title where it appears in the text. The ToC can be updated by right-clicking and selecting Update Field.

I have indicated my suggestions for who should take the lead in inserting text in each section based on who I think probably has material to hand already, or can produce something quickly. However everyone will have a chance to contribute to every section before we are finished, so the suggestion is just for the purpose of getting the ball rolling. Also we can add sections if you think something is missing.

From another project I worked on previously I already have summaries regarding extreme weather from all IPCC reports since SREX in 2012 so I will go ahead and insert those.

Cheers,  
Ross

---

**From:** Steven Koonin <steven.koonin@gmail.com>  
**Sent:** Saturday, April 12, 2025 10:32 AM  
**To:** 'Ross McKittrick'; 'Roy W. Spencer'; 'John Christy'  
**Subject:** RE: Saturday Apr 12 draft

Lookin' good. I'm ready to dig in!

SEK

---

**From:** Ross McKittrick <ross.mckittrick@gmail.com>  
**Sent:** Saturday, April 12, 2025 10:14 AM  
**To:** Steven Koonin <steven.koonin@gmail.com>; Roy W. Spencer <roywspencer@hotmail.com>; John Christy <climateman60@gmail.com>  
**Subject:** Saturday Apr 12 draft

I've taken Steve's suggested outline and added some sections based on another summary document someone sent me earlier. In the attached Word document the section titles are entered using heading formats so a Table of Contents can be automatically generated as shown. In other words don't edit the Table of Contents, if you want to rename a section edit the title where it appears in the text. The ToC can be updated by right-clicking and selecting Update Field.

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From another project I worked on previously I already have summaries regarding extreme weather from all IPCC reports since SREX in 2012 so I will go ahead and insert those.

Cheers,  
Ross

---

**From:** Ross McKittrick [ross.mckittrick@gmail.com]  
**Sent:** 4/12/2025 2:13:54 PM  
**To:** Steven Koonin [steven.koonin@gmail.com]; Roy W. Spencer [roywspencer@hotmail.com]; John Christy [climatemanager60@gmail.com]  
**Subject:** Saturday Apr 12 draft  
**Attachments:** Outline.Apr12.[RM].docx

I've taken Steve's suggested outline and added some sections based on another summary document someone sent me earlier. In the attached Word document the section titles are entered using heading formats so a Table of Contents can be automatically generated as shown. In other words don't edit the Table of Contents, if you want to rename a section edit the title where it appears in the text. The ToC can be updated by right-clicking and selecting Update Field.

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Cheers,

Ross

**CONFIDENTIAL**  
**FOR DISCUSSION PURPOSES ONLY**

**Current Scientific Understanding of US Greenhouse Gas Emissions from Motor  
Vehicles as an Endangerment to US Citizens**

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# **1 Introduction**

## **1.1 Definition of climate [SK]**

- Climate is the long-term stats of weather. Typically 30 years. It involves averages, variations, extreme events. The weather any one year does not a climate make
- There are other components of the climate beyond the atmosphere – oceans are very important, ice, biosphere, solid earth

## **1.2 How climate conditions are measured [JC]**

- Poor records in the past – the earth is big, the ocean largely unobserved
- Modern day measurement systems for temperature and precipitation

## **1.3 Drivers of climate change**

### **1.3.1 Natural internal variability [SK]**

- The climate varies a lot on its own
  - o From place to place
  - o From time to time via internal dynamics
  - o Interacting nonlinear chaotic systems

### **1.3.2 Natural externally forced changes [RS]**

Text text text.

### **1.3.3 Anthropogenically-forced changes [RS]**

Text text text.

## **1.4 Modeling the climate system**

### **1.4.1 Outline of climate model construction [SK]**

Text text text.

### **1.4.2 Can climate models reproduce the recent past? [RS]**

Text text text.

### **1.4.3 Modeling the carbon cycle [RS]**

Text text text.

#### 1.4.4 Emission scenarios and climate projections [RS]

Text text text.

### **1.5 Proving causation in climate change**

#### 1.5.1 The fingerprinting method [RM]

Text text text.

#### 1.5.2 Time series methods [RM]

Text text text.

### **1.6 Measuring climate sensitivity to forcing**

#### 1.6.1 Model-based methods [RS]

Text text text.

#### 1.6.2 Empirical methods [RM]

Text text text.

### **1.7 Summary**

Text text text.

## **2 Has the US climate become more dangerous over time?**

### **2.1 How do people adapt to weather hazards and have they reduced climate-related risks?**

#### 2.1.1 Mortality risks from extreme heat and cold [RS]

Text text text.

#### 2.1.2 Forecasting systems for extreme weather [JC]

Text text text.

#### 2.1.3 Other adaptation measures [JC]

Text text text.

## 2.2 What is known about trends and attributable changes in extreme weather?

### Official Assessments:

**SREX:** The IPCC *Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* (2012)

**AR5:** The IPCC *Fifth Assessment Report Working Group 1* (2013)

**AR6:** The IPCC *Sixth Assessment Report Working Group 1* (2021)

**NCA17:** The *US Climate Science Special Report of the Fourth National Climate Assessment* (2017) Volume I Chapter 6.

### 2.2.1 Floods

#### 2.2.1.1 IPCC and other official assessments [RM]

Text text text.

#### 2.2.1.2 Other scientific sources [RS]

Text text text.

### 2.2.2 Heatwaves

#### 2.2.2.1 IPCC and other official assessments [RM]

Text text text.

#### 2.2.2.2 Other scientific sources [RS]

Text text text.

### 2.2.3 Blizzards and extreme cold

#### 2.2.3.1 IPCC and other official assessments [RM]

Text text text.

#### 2.2.3.2 Other scientific sources [RS]

Text text text.

#### 2.2.4 Extreme precipitation

##### *2.2.4.1 IPCC and other official assessments [RM]*

Text text text.

##### *2.2.4.2 Other scientific sources [RS]*

Text text text.

#### 2.2.5 Tornadoes

##### *2.2.5.1 IPCC and other official assessments [RM]*

Text text text.

##### *2.2.5.2 Other scientific sources [RS]*

Text text text.

#### 2.2.6 Hurricanes

##### *2.2.6.1 IPCC and other official assessments [RM]*

Text text text.

##### *2.2.6.2 Other scientific sources [RS]*

Text text text.

#### 2.2.7 Wildfires

##### *2.2.7.1 IPCC and other official assessments [RM]*

Text text text.

#### *2.2.7.2 Other scientific sources [RS]*

Text text text.

### **2.2.8 Droughts**

#### *2.2.8.1 IPCC and other official assessments [RM]*

Text text text.

#### *2.2.8.2 Other scientific sources [RS]*

Text text text.

### **2.3 IPCC Assessment of signal emergence in extreme weather types [RS]** (IPCC WG1 Table 12.12)

### **2.4 Changes in sea level [RS]**

Text text text

### **2.5 Extreme weather event attribution [RM]**

Text text text.

### **2.6 Summary**

Text text text.

## **3 Other impacts of climate change**

### **3.1 Climate change and global greening [RS]**

Text text text.

### **3.2 Climate change and US agriculture [RM]**

Text text text.

### **3.3 Climate change and economic growth [RM]**

Text text text.

### **3.4 Climate change and US ozone levels [RS]**

Text text text.

### **3.5 Climate change and vector-borne diseases [RS]**

Text text text.

### **3.6 Estimates of the Social Cost of Carbon [RM]**

Text text text.

### **3.7 Summary**

Text text text.

## **4 The role of US motor vehicle transportation in the climate system**

### **4.1 US CO<sub>2</sub> emissions by sector [RS]**

Text text text.

### **4.2 US vehicle emissions as a fraction of global CO<sub>2</sub> emissions [RS]**

Text text text.

### **4.3 Estimating the effect on the global climate system of variations in US tailpipe CO<sub>2</sub> emissions [RS]**

Text text text.

### **4.4 Summary**

Text text text.

## **5 Conclusions**

### **5.1 Conclusions as to whether US weather is materially more dangerous than in the past**

Text text text.

## **5.2 Conclusions as to whether GHGs have a well-understood role in making the weather more dangerous**

Text text text.

## **5.3 Conclusions as to the role of US vehicle emissions in global climate change**

Text text text.

## **5.4 Final comments and conclusions**

Text text text.

---

**From:** John Christy <climateman60@gmail.com>  
**Sent:** Wednesday, April 16, 2025 4:48 PM  
**To:** Ross McKittrick  
**Cc:** Steve Koonin; Roy Spencer  
**Subject:** Re: [2.2.4]Apr15[JC] Ext Precip

Got it. Roy - this is mostly for you since you have the extreme sections. Looks like nothing really remarkable.

John C.

On Wed, Apr 16, 2025 at 2:30 PM Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:

John, here's a folder of outputs from the SE data. The charts show the trends by location, open circles mean insignificant. In each of the tables I also show the trends in averaged locations (coastal, inland and all). Probably the trends in annual max rainfall are most useful for the present purposes but everything is there. I'll work on running the Pacific stations.

On Tue, Apr 15, 2025 at 5:20 PM John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)> wrote:  
Ross

Attached is file for the Pacific Coastal stations (29) San Francisco began in 1849, but this list starts in 1877 with 3 stations reporting back then. All stations are complete from 1893-2024.

It's common practice to use the Water Year calendar in the West. Hydrologists use Oct-Sep for water management tasks, I use Aug-Jul because 1 Aug is the climatological driest day on the West Coast.

Attached is an example answering the question, "When did the 13 heaviest events occur along the Pacific Coast? (i.e., 1-in-10yr occurrence in 130 years). This result indicates Atmospheric Rivers are variable, but not trendy. The big El Nino of 1997-98 stands out. 29 stations times 13 events divided by 26 5-yr intervals gives an expected value of 14.5 events per interval. Note, lowest value in 2015-2019.

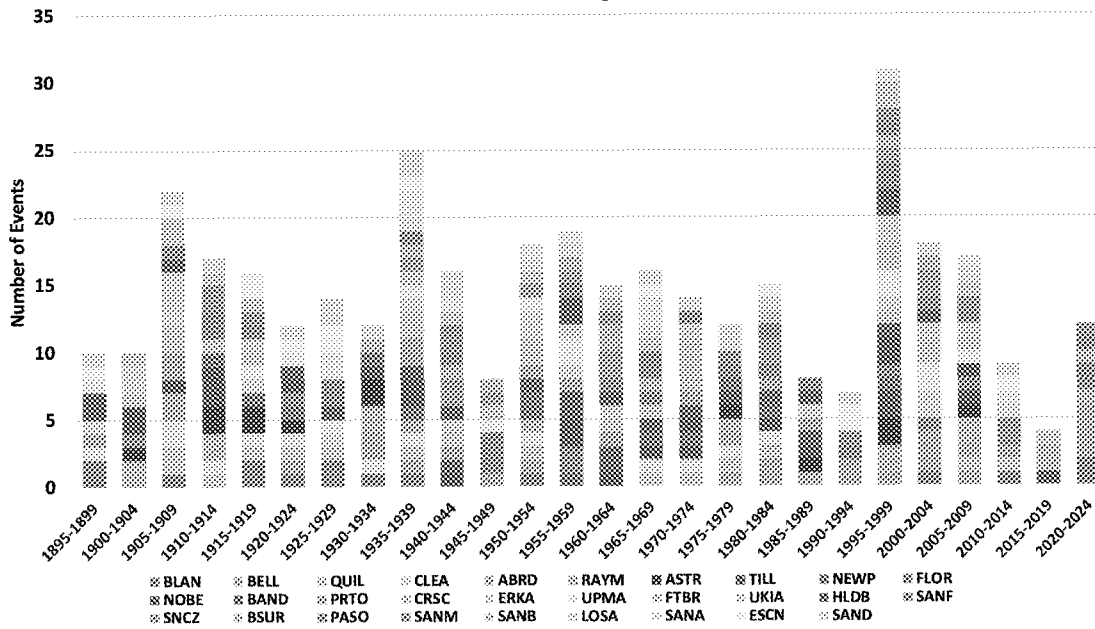
Same plot for the 24 humid SE stations. You can see the rise in the last few intervals due to the 4 eastern-most stations (3rd plot). I've double checked the observations with other stations and this result is real ... and it goes up to Maine (as I mentioned due to a series of tropical systems that hit the area between 1995 and 2019.

Let me know if anyone writing about this stuff is interested in any associated plots.

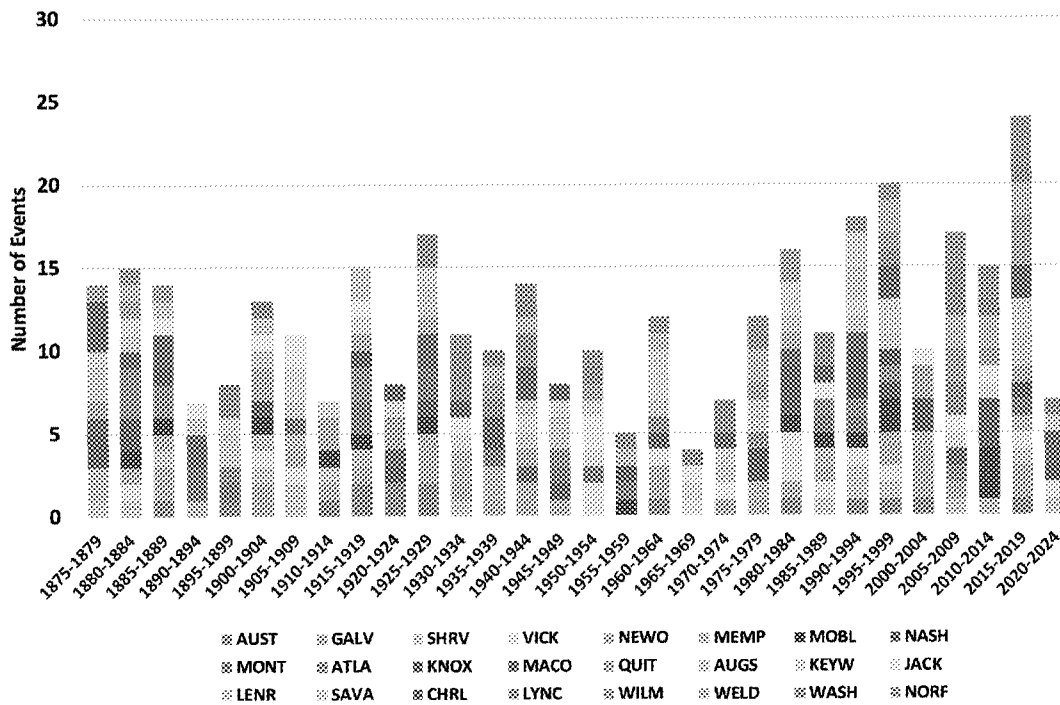
John C.



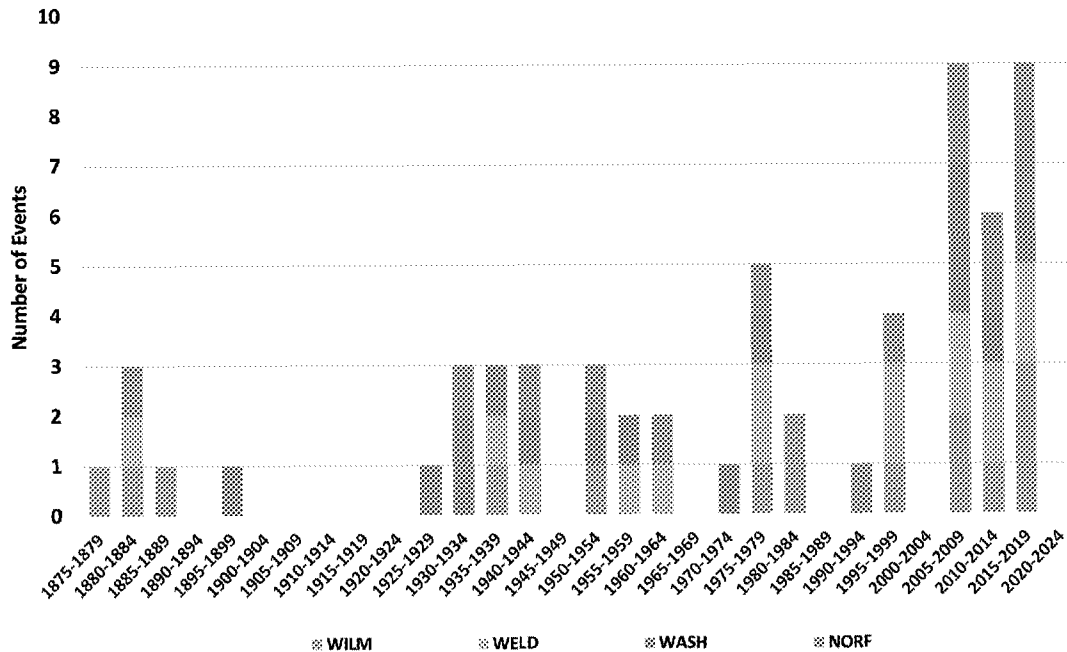
**Distribution of Heaviest 5-day Events by 5-yr periods**  
**29 Pacific Coast Stations from San Diego CA to Blaine WA**  
**Each station contributes 13 events (i.e., nominal 1 in 10-year occurrence)**  
**Water Year Aug-July**



**Distribution of 15 Heaviest Events per 5-year period**  
**Each station contributes 15 events (i.e., nominal 1 in 10-year occurrence)**  
**24 Stations in Humid Southeast, 1874-2023 Austin TX to Wash DC**



**Distribution of 15 Heaviest Events per 5-year period**  
**Each station contributes 15 events (i.e., nominal 1 in 10-year occurrence)**  
**4 Stations in Humid Southeast, 1874-2023 eNC, eVA, DC**



On Tue, Apr 15, 2025 at 3:18 PM Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:  
 Sure I can run that. Last year you send me long daily SE Humid zone records and I wrote the code to analyse those but never got around to writing up the results.

On Tue, Apr 15, 2025 at 11:49 AM John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)> wrote:  
 Ross

Attached is the updated daily precip (no missings) of 24 stations in the humid SE which, if your code is still handy, could be used as an update to our 2019 paper. Data are Oct 1872 to Dec 2024, so you could use either Oct - Sep Water year or calendar year (152 total years). Station list is in second tab.

Note: The four eastern-most stations account for the increase in heavy (5-day) events in last 25 years. This is seen in observations from eastern North Carolina up to Maine due to several tropical systems that drifted that way in the past 25 years and evidently accounts for the upward trend in heavy events in that part of the US.

I will send an update of the 29 Pacific Coastal stations which show no change in say 5-day extremes suggesting Atmospheric Rivers show no intensification.

John C.

---

**From:** Ross McKittrick [ross.mckittrick@gmail.com]  
**Sent:** 4/16/2025 7:30:04 PM  
**To:** John Christy [climateman60@gmail.com]  
**CC:** Steve Koonin [steven.koonin@gmail.com]; Roy Spencer [roywspencer@hotmail.com]  
**Subject:** Re: [2.2.4]Apr15[JC] Ext Precip  
**Attachments:** Pac\_5d13ev.png; SE\_5d15ev.png; SE\_5d15ev\_4stnsE.png; SE\_Humid\_Apr.16.2025.zip

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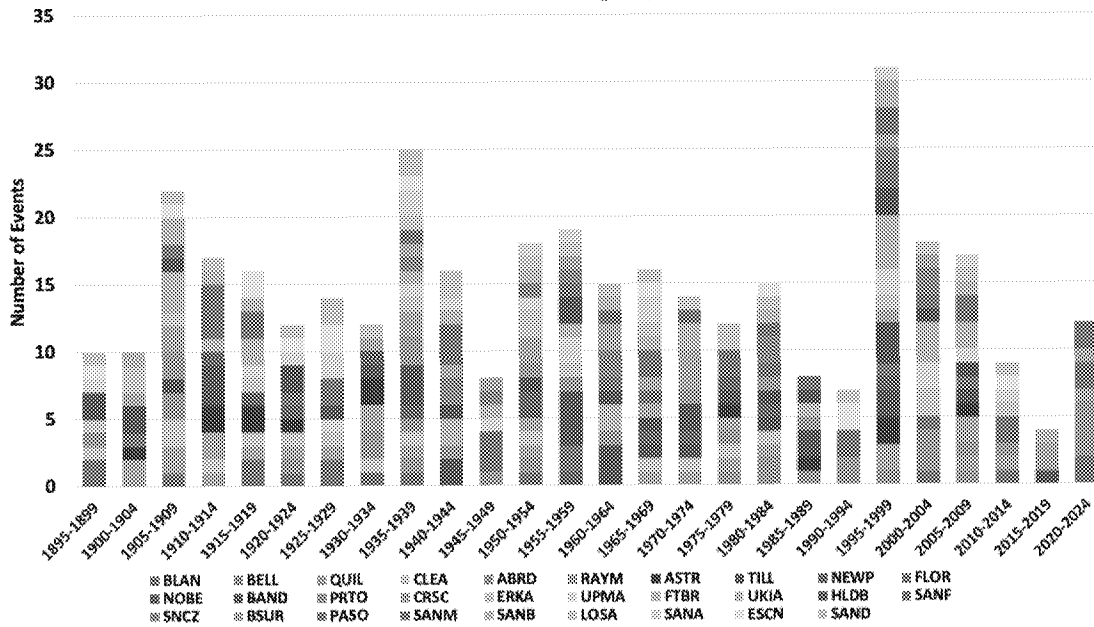
Attached is an example answering the question, "When did the 13 heaviest events occur along the Pacific Coast? (i.e., 1-in-10yr occurrence in 130 years). This result indicates Atmospheric Rivers are variable, but not trendy. The big El Nino of 1997-98 stands out. 29 stations times 13 events divided by 26 5-yr intervals gives an expected value of 14.5 events per interval. Note, lowest value in 2015-2019.

Same plot for the 24 humid SE stations. You can see the rise in the last few intervals due to the 4 eastern-most stations (3rd plot). I've double checked the observations with other stations and this result is real ... and it goes up to Maine (as I mentioned due to a series of tropical systems that hit the area between 1995 and 2019.

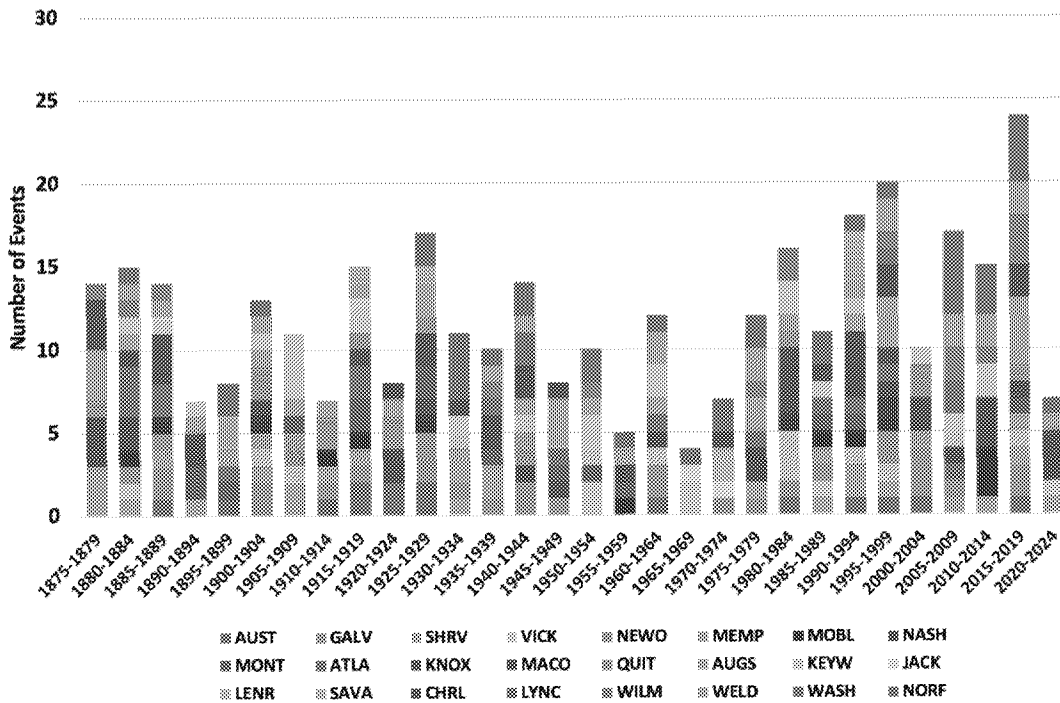
Let me know if anyone writing about this stuff is interested in any associated plots.

John C.

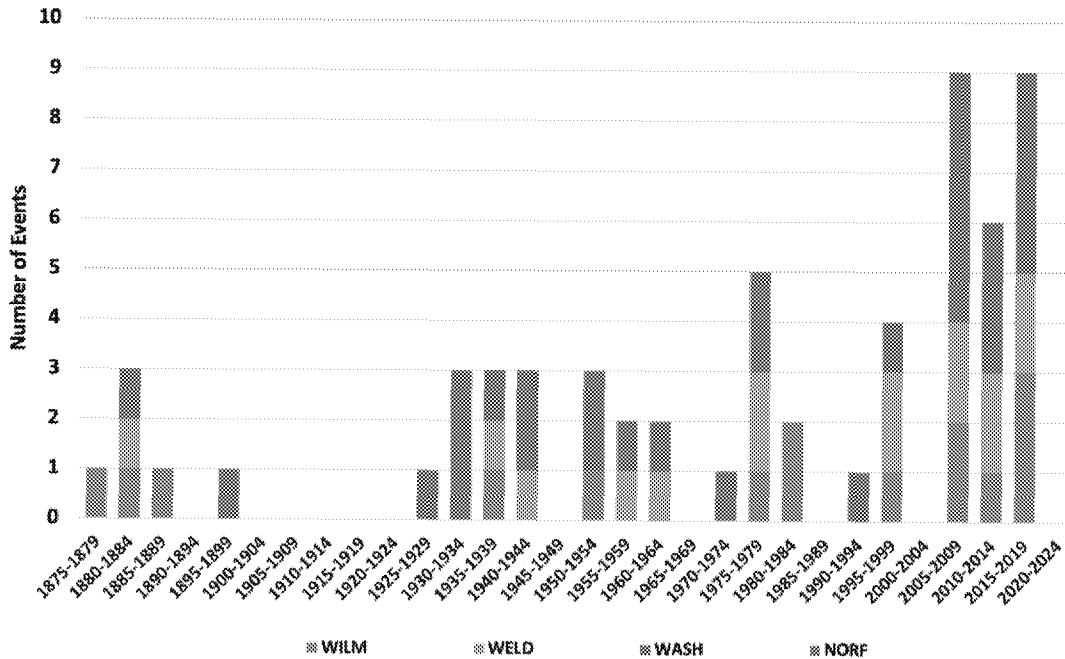
**Distribution of Heaviest 5-day Events by 5-yr periods**  
**29 Pacific Coast Stations from San Diego CA to Blaine WA**  
 Each station contributes 13 events (i.e., nominal 1 in 10-year occurrence)  
 Water Year Aug-July



**Distribution of 15 Heaviest Events per 5-year period**  
**Each station contributes 15 events (i.e., nominal 1 in 10-year occurrence)**  
**24 Stations in Humid Southeast, 1874-2023 Austin TX to Wash DC**



**Distribution of 15 Heaviest Events per 5-year period**  
**Each station contributes 15 events (i.e., nominal 1 in 10-year occurrence)**  
**4 Stations in Humid Southeast, 1874-2023 eNC, eVA, DC**



On Tue, Apr 15, 2025 at 3:18 PM Ross McKittrick <[ross.mckittrick@gmail.com](mailto:ross.mckittrick@gmail.com)> wrote:

Sure I can run that. Last year you send me long daily SE Humid zone records and I wrote the code to analyse those but never got around to writing up the results.

On Tue, Apr 15, 2025 at 11:49 AM John Christy <[climateman60@gmail.com](mailto:climateman60@gmail.com)> wrote:

Ross

Attached is the updated daily precip (no missings) of 24 stations in the humid SE which, if your code is still handy, could be used as an update to our 2019 paper. Data are Oct 1872 to Dec 2024, so you could use either Oct - Sep Water year or calendar year (152 total years). Station list is in second tab.

Note: The four eastern-most stations account for the increase in heavy (5-day) events in last 25 years. This is seen in observations from eastern North Carolina up to Maine due to several tropical systems that drifted that way in the past 25 years and evidently accounts for the upward trend in heavy events in that part of the US.

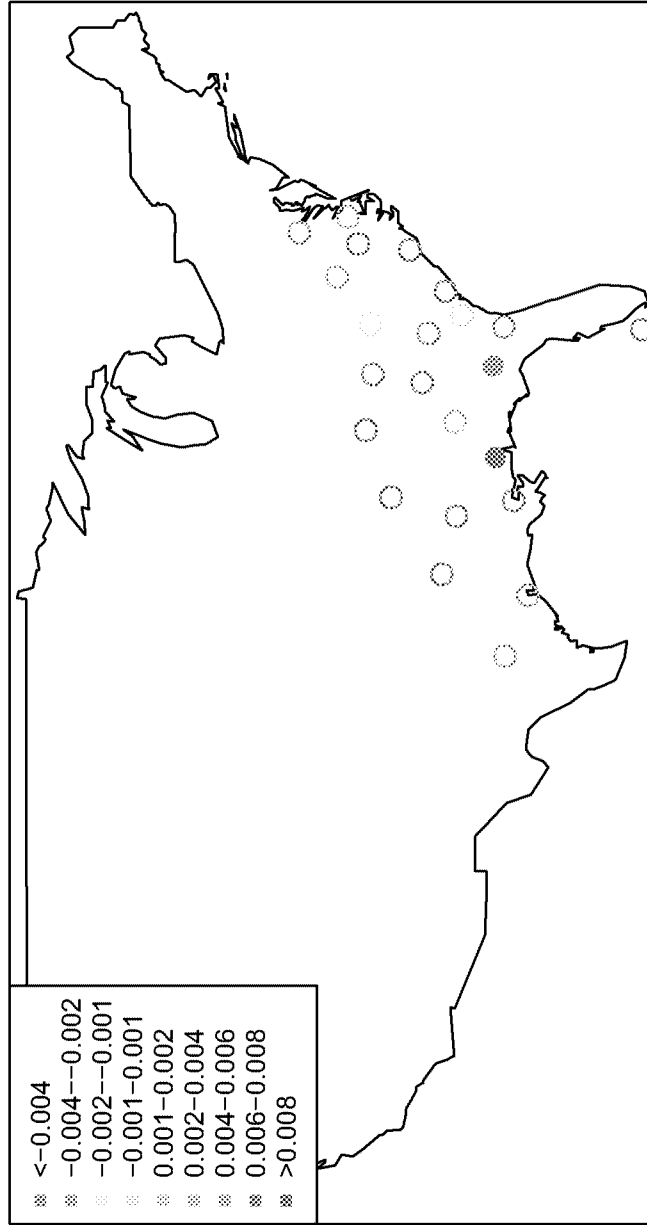
I will send an update of the 29 Pacific Coastal stations which show no change in say 5-day extremes suggesting Atmospheric Rivers show no intensification.

John C.

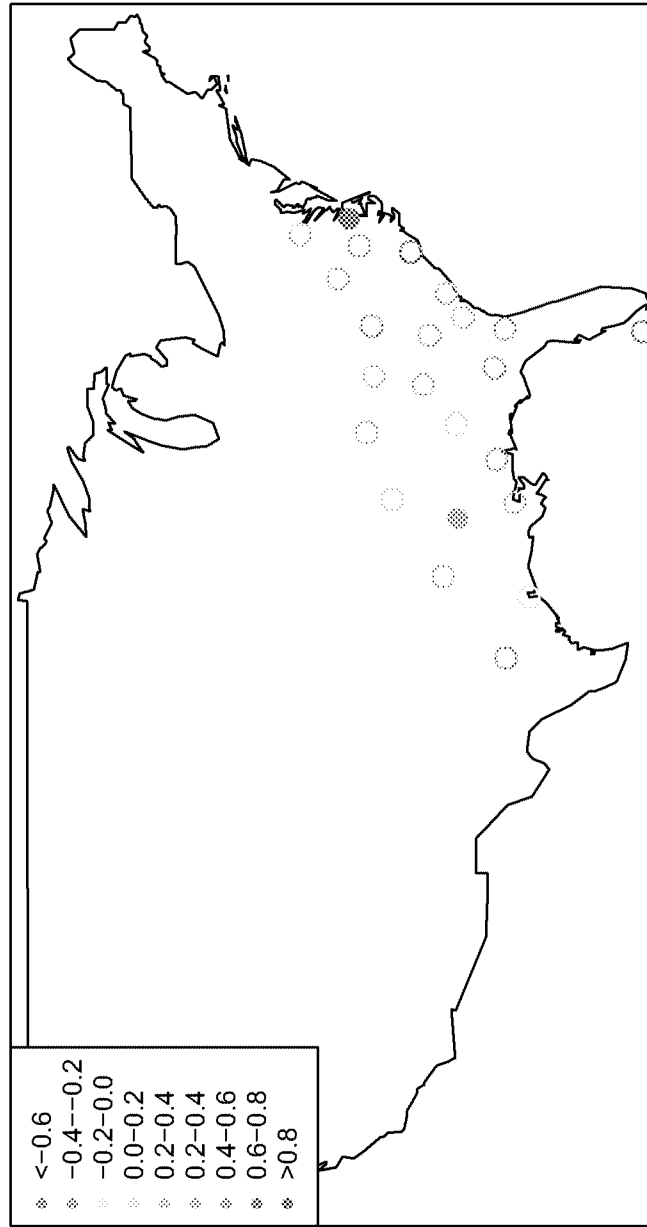
Trends in Annual Rainfall Totals (inches)



**Trends in Annual Average 2-day Rainfall Totals (inches)**



# Trends in Annual Maximum Rainfall since 1873





|                | "Trend" | "CI-lower" | "CI-upper" | "Sig" |
|----------------|---------|------------|------------|-------|
| "Austin"       | -0.0056 | -0.0511    | 0.0398     | 0     |
| "Galveston"    | -0.0169 | -0.097     | 0.0632     | 0     |
| "Shreveport"   | 0.049   | -0.0447    | 0.1427     | 0     |
| "Vicksburg"    | 0.0208  | -0.0682    | 0.1097     | 0     |
| "New Orleans"  | 0.0428  | -0.0148    | 0.1004     | 0     |
| "Memphis"      | 0.0506  | -0.0491    | 0.1502     | 0     |
| "Mobile"       | 0.0421  | 0.004      | 0.0803     | 1     |
| "Nashville"    | 0.0151  | -0.0609    | 0.0911     | 0     |
| "Montgomery"   | 0.0043  | -0.038     | 0.0466     | 0     |
| "Atlanta"      | 0.0188  | -0.0252    | 0.0627     | 0     |
| "Knoxville"    | 0.0112  | -0.0693    | 0.0916     | 0     |
| "Macon"        | -0.0171 | -0.0778    | 0.0436     | 0     |
| "Quitman"      | -0.0364 | -0.0621    | -0.0107    | 1     |
| "Augusta"      | -0.0107 | -0.0719    | 0.0504     | 0     |
| "Key West"     | 0.016   | -0.0057    | 0.0377     | 0     |
| "Jacksonville" | 0.0139  | -0.0456    | 0.0733     | 0     |
| "Lenoir"       | -0.0023 | -0.0455    | 0.041      | 0     |
| "Savannah"     | -0.0014 | -0.0536    | 0.0508     | 0     |
| "Charleston"   | 0.0327  | -0.0929    | 0.1583     | 0     |
| "Lynchburg"    | 0.0081  | -0.0578    | 0.074      | 0     |
| "Wilmington"   | 0.0828  | -0.0251    | 0.1908     | 0     |
| "Weldon"       | 0.0403  | -0.0376    | 0.1181     | 0     |
| "Washington"   | -0.018  | -0.0721    | 0.0361     | 0     |
| "Norfolk"      | 0.0084  | -0.0947    | 0.1114     | 0     |
| "Coastal"      | 0.2204  | -0.299     | 0.7399     | 0     |
| "Inland"       | 0.1279  | -0.6884    | 0.9443     | 0     |
| "All"          | 0.3484  | -0.9415    | 1.6382     | 0     |

|                | "Trend" | "CI-lower" | "CI-upper" | "Sig" |
|----------------|---------|------------|------------|-------|
| "Austin"       | -0.0031 | -0.028     | 0.0218     | 0     |
| "Galveston"    | -0.0092 | -0.0531    | 0.0347     | 0     |
| "Shreveport"   | 0.0269  | -0.0245    | 0.0782     | 0     |
| "Vicksburg"    | 0.0114  | -0.0373    | 0.0601     | 0     |
| "New Orleans"  | 0.0235  | -0.0081    | 0.055      | 0     |
| "Memphis"      | 0.0277  | -0.0269    | 0.0823     | 0     |
| "Mobile"       | 0.0231  | 0.0022     | 0.044      | 1     |
| "Nashville"    | 0.0083  | -0.0333    | 0.0499     | 0     |
| "Montgomery"   | 0.0024  | -0.0209    | 0.0256     | 0     |
| "Atlanta"      | 0.0103  | -0.0138    | 0.0344     | 0     |
| "Knoxville"    | 0.0061  | -0.0379    | 0.0502     | 0     |
| "Macon"        | -0.0094 | -0.0426    | 0.0239     | 0     |
| "Quitman"      | -0.0199 | -0.034     | -0.0058    | 1     |
| "Augusta"      | -0.0059 | -0.0394    | 0.0276     | 0     |
| "Key West"     | 0.0088  | -0.0031    | 0.0207     | 0     |
| "Jacksonville" | 0.0076  | -0.025     | 0.0402     | 0     |
| "Lenoir"       | -0.0012 | -0.0249    | 0.0225     | 0     |
| "Savannah"     | -0.0007 | -0.0293    | 0.0278     | 0     |
| "Charleston"   | 0.0179  | -0.0509    | 0.0868     | 0     |
| "Lynchburg"    | 0.0044  | -0.0316    | 0.0405     | 0     |
| "Wilmington"   | 0.0454  | -0.0138    | 0.1046     | 0     |
| "Weldon"       | 0.0221  | -0.0206    | 0.0647     | 0     |
| "Washington"   | -0.0098 | -0.0395    | 0.0198     | 0     |
| "Norfolk"      | 0.0046  | -0.0518    | 0.0611     | 0     |
| "Coastal"      | 0.121   | -0.1636    | 0.4056     | 0     |
| "Inland"       | 0.0703  | -0.377     | 0.5176     | 0     |
| "All"          | 0.1913  | -0.5154    | 0.898      | 0     |

|                | "Trend" | "CI-lower" | "CI-upper" | "Sig" |
|----------------|---------|------------|------------|-------|
| "Austin"       | -0.1446 | -0.3277    | 0.0385     | 0     |
| "Galveston"    | 0.0146  | -0.0215    | 0.0506     | 0     |
| "Shreveport"   | 0.0612  | 0.0033     | 0.119      | 1     |
| "Vicksburg"    | 0.0544  | -0.0265    | 0.1353     | 0     |
| "New Orleans"  | 0.0638  | 0.0178     | 0.1099     | 1     |
| "Memphis"      | 0.0557  | 0.0204     | 0.091      | 1     |
| "Mobile"       | 0.0456  | 0.008      | 0.0833     | 1     |
| "Nashville"    | 0.0285  | 0.0086     | 0.0483     | 1     |
| "Montgomery"   | 0.0334  | -0.0053    | 0.0721     | 0     |
| "Atlanta"      | 0.022   | -0.036     | 0.0799     | 0     |
| "Knoxville"    | 0.0271  | -0.0086    | 0.0628     | 0     |
| "Macon"        | -0.1608 | -0.4328    | 0.1113     | 0     |
| "Quitman"      | -0.2412 | -0.3368    | -0.1457    | 1     |
| "Augusta"      | 0.0113  | -0.0166    | 0.0391     | 0     |
| "Key West"     | 0.0405  | 0.0263     | 0.0547     | 1     |
| "Jacksonville" | 0.0481  | -0.0005    | 0.0968     | 0     |
| "Lenoir"       | -0.2276 | -0.4022    | -0.053     | 1     |
| "Savannah"     | 0.0313  | -0.0028    | 0.0653     | 0     |
| "Charleston"   | 0.0422  | -0.0467    | 0.131      | 0     |
| "Lynchburg"    | 0.0207  | -0.0243    | 0.0657     | 0     |
| "Wilmington"   | 0.0825  | 0.0244     | 0.1407     | 1     |
| "Weldon"       | -0.0112 | -0.1767    | 0.1542     | 0     |
| "Washington"   | 0.015   | -0.0023    | 0.0323     | 0     |
| "Norfolk"      | 0.0402  | -0.0085    | 0.089      | 0     |
| "Coastal"      | 0.1162  | -0.0143    | 0.2467     | 0     |
| "Inland"       | -0.0261 | -0.3261    | 0.2738     | 0     |
| "All"          | 0.0968  | -0.2752    | 0.4688     | 0     |

|                | "Trend" | "CI-lower" | "CI-upper" | "Sig" |
|----------------|---------|------------|------------|-------|
| "Austin"       | -0.0193 | -0.0647    | 0.0262     | 0     |
| "Galveston"    | -0.0168 | -0.0645    | 0.0308     | 0     |
| "Shreveport"   | 0.0313  | -0.0282    | 0.0907     | 0     |
| "Vicksburg"    | 0.0251  | -0.0191    | 0.0694     | 0     |
| "New Orleans"  | 0.0442  | -0.0047    | 0.0931     | 0     |
| "Memphis"      | 0.0218  | -0.0155    | 0.059      | 0     |
| "Mobile"       | 0.0444  | 0.0108     | 0.0779     | 1     |
| "Nashville"    | 0.0156  | -0.0142    | 0.0454     | 0     |
| "Montgomery"   | 0.0065  | -0.0155    | 0.0286     | 0     |
| "Atlanta"      | 0.0155  | -0.0154    | 0.0465     | 0     |
| "Knoxville"    | 0.0084  | -0.0258    | 0.0427     | 0     |
| "Macon"        | -0.0298 | -0.1134    | 0.0539     | 0     |
| "Quitman"      | -0.0438 | -0.0972    | 0.0096     | 0     |
| "Augusta"      | 0.0095  | -0.0178    | 0.0368     | 0     |
| "Key West"     | 0.0397  | -0.0109    | 0.0904     | 0     |
| "Jacksonville" | 0.0219  | -0.0134    | 0.0571     | 0     |
| "Lenoir"       | -0.0397 | -0.1119    | 0.0324     | 0     |
| "Savannah"     | 0.0155  | -0.0098    | 0.0407     | 0     |
| "Charleston"   | 0.018   | -0.0637    | 0.0997     | 0     |
| "Lynchburg"    | 0.0078  | -0.017     | 0.0327     | 0     |
| "Wilmington"   | 0.0914  | -0.006     | 0.1888     | 0     |
| "Weldon"       | 0.0156  | -0.0653    | 0.0966     | 0     |
| "Washington"   | -0.0037 | -0.0236    | 0.0163     | 0     |
| "Norfolk"      | 0.0397  | -0.0153    | 0.0948     | 0     |
| "Coastal"      | 0.5466  | -0.0855    | 1.1788     | 0     |
| "Inland"       | -0.1725 | -2.0315    | 1.6865     | 0     |
| "All"          | 0.9239  | -2.6116    | 4.4595     | 0     |

|                | "Trend" | "CI-lower" | "CI-upper" | "Sig" |
|----------------|---------|------------|------------|-------|
| "Austin"       | -0.4126 | -1.3394    | 0.5142     | 0     |
| "Galveston"    | -0.3131 | -1.1154    | 0.4893     | 0     |
| "Shreveport"   | 0.1345  | -0.7354    | 1.0043     | 0     |
| "Vicksburg"    | 0.4425  | 0.0254     | 0.8595     | 1     |
| "New Orleans"  | 0.2529  | -0.5796    | 1.0855     | 0     |
| "Memphis"      | -0.0984 | -0.6483    | 0.4515     | 0     |
| "Mobile"       | 0.5101  | -0.0286    | 1.0487     | 0     |
| "Nashville"    | 0.153   | -0.3503    | 0.6563     | 0     |
| "Montgomery"   | -0.0362 | -0.7458    | 0.6734     | 0     |
| "Atlanta"      | 0.2255  | -0.2161    | 0.667      | 0     |
| "Knoxville"    | 0.1281  | -0.1064    | 0.3627     | 0     |
| "Macon"        | -0.5225 | -1.6686    | 0.6237     | 0     |
| "Quitman"      | -0.5879 | -1.4677    | 0.292      | 0     |
| "Augusta"      | 0.3468  | -0.1117    | 0.8052     | 0     |
| "Key West"     | 0.6592  | -0.2485    | 1.5668     | 0     |
| "Jacksonville" | 0.4021  | -0.3265    | 1.1307     | 0     |
| "Lenoir"       | -0.5949 | -1.6687    | 0.4788     | 0     |
| "Savannah"     | 0.192   | -0.344     | 0.7281     | 0     |
| "Charleston"   | 0.3682  | -0.2388    | 0.9751     | 0     |
| "Lynchburg"    | 0.2251  | -0.1788    | 0.6289     | 0     |
| "Wilmington"   | 1.1429  | -0.2246    | 2.5105     | 0     |
| "Weldon"       | 0.3309  | -1.1542    | 1.8159     | 0     |
| "Washington"   | 0.0016  | -0.6074    | 0.6106     | 0     |
| "Norfolk"      | 1.0065  | 0.0957     | 1.9173     | 1     |
| "Coastal"      | 1.39    | 0.3461     | 2.4339     | 1     |
| "Inland"       | -0.522  | -2.6805    | 1.6364     | 0     |
| "All"          | 0.8218  | -1.1368    | 2.7804     | 0     |

|                | "Trend" | "CI-lower" | "CI-upper" | "Sig" |
|----------------|---------|------------|------------|-------|
| "Austin"       | -0.0006 | -0.0028    | 0.0017     | 0     |
| "Galveston"    | 0.0003  | -0.0012    | 0.0019     | 0     |
| "Shreveport"   | 0.0022  | -0.001     | 0.0054     | 0     |
| "Vicksburg"    | 0.0002  | -0.0016    | 0.002      | 0     |
| "New Orleans"  | 0.0009  | -0.0017    | 0.0034     | 0     |
| "Memphis"      | -0.0001 | -0.0035    | 0.0033     | 0     |
| "Mobile"       | 0.001   | -0.0006    | 0.0026     | 0     |
| "Nashville"    | -0.0007 | -0.0027    | 0.0014     | 0     |
| "Montgomery"   | -0.0007 | -0.0023    | 0.0009     | 0     |
| "Atlanta"      | 0.0016  | 0.0001     | 0.003      | 1     |
| "Knoxville"    | 0.0007  | -0.0009    | 0.0022     | 0     |
| "Macon"        | -0.0011 | -0.0039    | 0.0017     | 0     |
| "Quitman"      | -0.0017 | -0.0041    | 0.0007     | 0     |
| "Augusta"      | 0.0026  | 0.0008     | 0.0044     | 1     |
| "Key West"     | 0.0011  | -0.0005    | 0.0027     | 0     |
| "Jacksonville" | 0.0004  | -0.0031    | 0.0039     | 0     |
| "Lenoir"       | -0.0019 | -0.0056    | 0.0019     | 0     |
| "Savannah"     | -0.0009 | -0.0028    | 0.001      | 0     |
| "Charleston"   | 0       | -0.0026    | 0.0025     | 0     |
| "Lynchburg"    | 0.0004  | -0.0019    | 0.0027     | 0     |
| "Wilmington"   | 0.0021  | -0.001     | 0.0053     | 0     |
| "Weldon"       | -0.0001 | -0.0051    | 0.0049     | 0     |
| "Washington"   | -0.0004 | -0.0026    | 0.0018     | 0     |
| "Norfolk"      | 0.0034  | 0.0003     | 0.0065     | 1     |
| "Coastal"      | 0.0139  | 0.0035     | 0.0243     | 1     |
| "Inland"       | -0.0052 | -0.0268    | 0.0164     | 0     |
| "All"          | 0.0082  | -0.0114    | 0.0278     | 0     |

|                | "Trend" | "CI-lower" | "CI-upper" | "Sig" |
|----------------|---------|------------|------------|-------|
| "Austin"       | -0.0001 | -0.0017    | 0.0015     | 0     |
| "Galveston"    | -0.0007 | -0.0013    | -0.0001    | 1     |
| "Shreveport"   | 0       | -0.0005    | 0.0006     | 0     |
| "Vicksburg"    | 0.0002  | -0.0003    | 0.0007     | 0     |
| "New Orleans"  | 0.0002  | -0.0001    | 0.0005     | 0     |
| "Memphis"      | 0.0001  | -0.0006    | 0.0008     | 0     |
| "Mobile"       | 0.0002  | -0.0001    | 0.0004     | 0     |
| "Nashville"    | 0.0001  | -0.0002    | 0.0004     | 0     |
| "Montgomery"   | 0.0002  | -0.0002    | 0.0005     | 0     |
| "Atlanta"      | 0       | 0          | 0          | 0     |
| "Knoxville"    | 0       | 0          | 0          | 0     |
| "Macon"        | 0       | -0.0004    | 0.0004     | 0     |
| "Quitman"      | 0.0002  | -0.0004    | 0.0007     | 0     |
| "Augusta"      | 0       | 0          | 0          | 0     |
| "Key West"     | 0.0002  | -0.0001    | 0.0005     | 0     |
| "Jacksonville" | 0.0001  | -0.0003    | 0.0004     | 0     |
| "Lenoir"       | 0       | 0          | 0          | 0     |
| "Savannah"     | 0       | 0          | 0          | 0     |
| "Charleston"   | 0.0001  | -0.0003    | 0.0004     | 0     |
| "Lynchburg"    | 0       | 0          | 0          | 0     |
| "Wilmington"   | 0.0003  | -0.0003    | 0.001      | 0     |
| "Weldon"       | 0.0001  | -0.0002    | 0.0004     | 0     |
| "Washington"   | 0       | 0          | 0          | 0     |
| "Norfolk"      | 0.0002  | -0.0004    | 0.0008     | 0     |
| "Coastal"      | 0.0139  | 0.0035     | 0.0243     | 1     |
| "Inland"       | -0.0052 | -0.0268    | 0.0164     | 0     |
| "All"          | 0.0082  | -0.0114    | 0.0278     | 0     |

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**From:** John Christy <climateman60@gmail.com>  
**Sent:** Tuesday, April 15, 2025 5:20 PM  
**To:** Ross McKittrick  
**Cc:** Steve Koonin; Roy Spencer  
**Subject:** Re: [2.2.4]Apr15[JC] Ext Precip  
**Attachments:** PacCoast\_Prcp\_20241231.xlsx

Ross

Attached is file for the Pacific Coastal stations (29) San Francisco began in 1849, but this list starts in 1877 with 3 stations reporting back then. All stations are complete from 1893-2024.

It's common practice to use the Water Year calendar in the West. Hydrologists use Oct-Sep for water management tasks, I use Aug-Jul because 1 Aug is the climatological driest day on the West Coast.

Attached is an example answering the question, "When did the 13 heaviest events occur along the Pacific Coast? (i.e., 1-in-10yr occurrence in 130 years). This result indicates Atmospheric Rivers are variable, but not trendy. The big El Nino of 1997-98 stands out. 29 stations times 13 events divided by 26 5-yr intervals gives an expected value of 14.5 events per interval. Note, lowest value in 2015-2019.

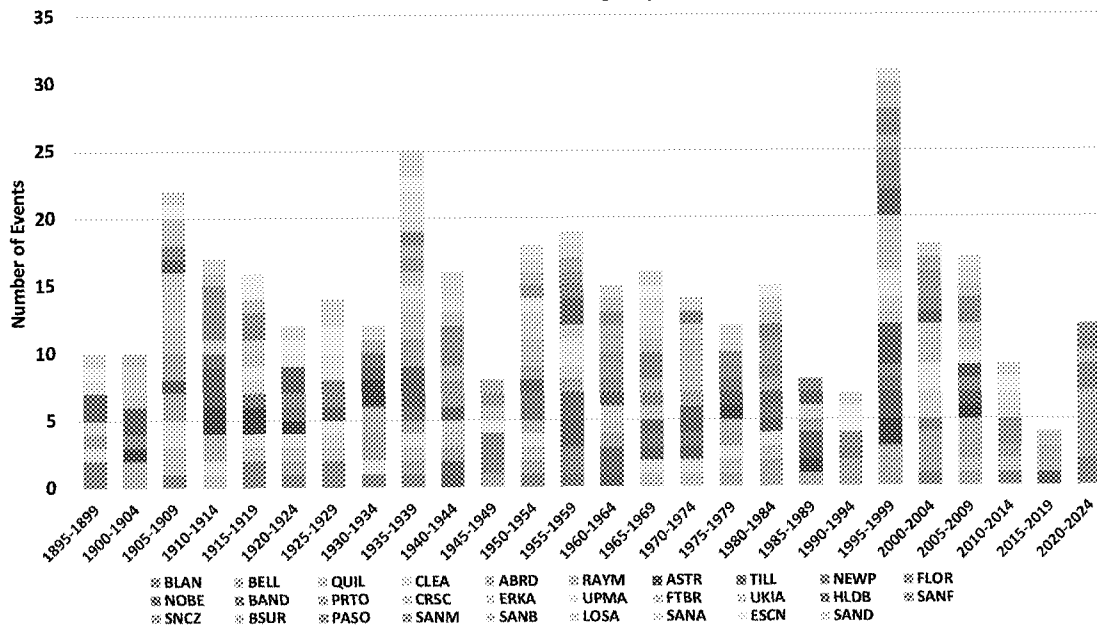
Same plot for the 24 humid SE stations. You can see the rise in the last few intervals due to the 4 eastern-most stations (3rd plot). I've double checked the observations with other stations and this result is real ... and it goes up to Maine (as I mentioned due to a series of tropical systems that hit the area between 1995 and 2019.

Let me know if anyone writing about this stuff is interested in any associated plots.

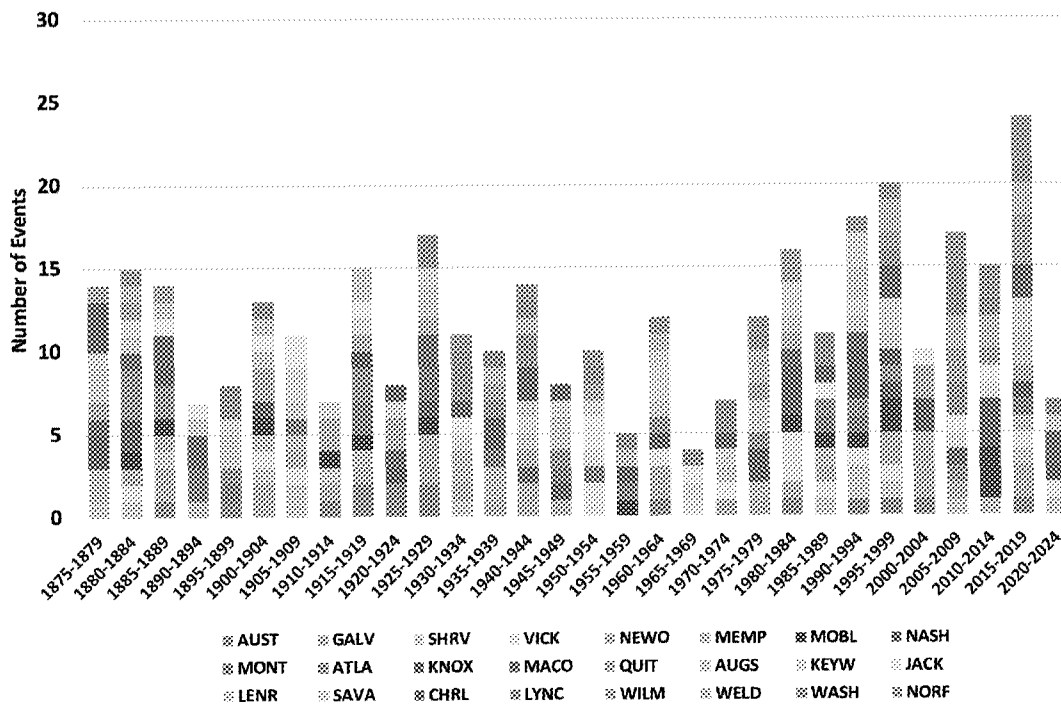
John C.



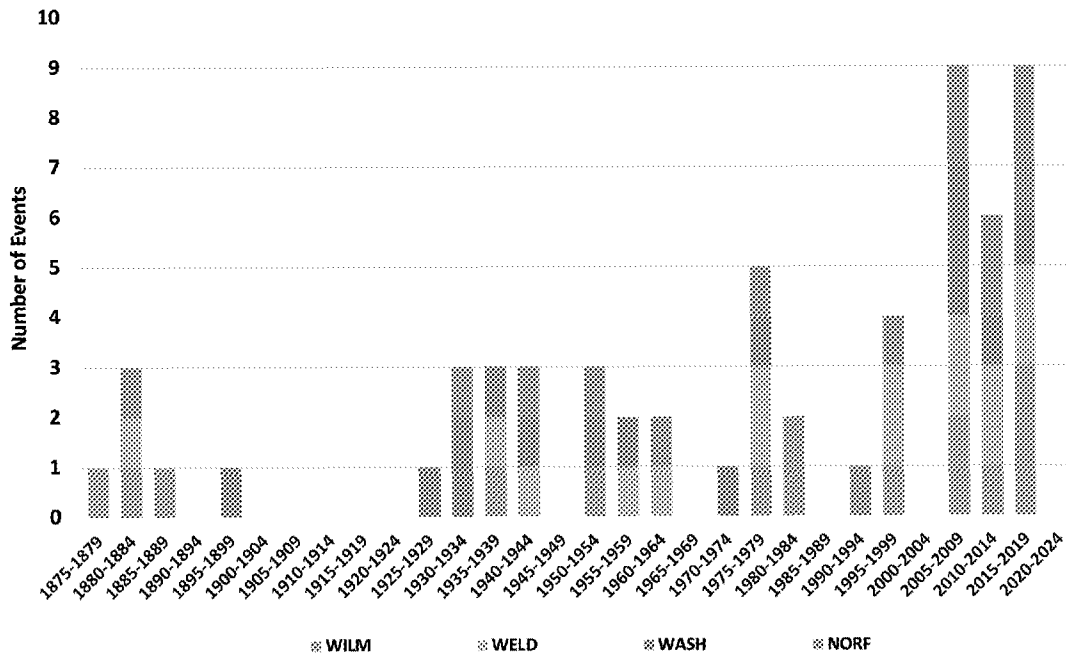
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 Each station contributes 13 events (i.e., nominal 1 in 10-year occurrence)  
 Water Year Aug-July



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**24 Stations in Humid Southeast, 1874-2023 Austin TX to Wash DC**



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Ross

Attached is the updated daily precip (no missings) of 24 stations in the humid SE which, if your code is still handy, could be used as an update to our 2019 paper. Data are Oct 1872 to Dec 2024, so you could use either Oct - Sep Water year or calendar year (152 total years). Station list is in second tab.

Note: The four eastern-most stations account for the increase in heavy (5-day) events in last 25 years. This is seen in observations from eastern North Carolina up to Maine due to several tropical systems that drifted that way in the past 25 years and evidently accounts for the upward trend in heavy events in that part of the US.

I will send an update of the 29 Pacific Coastal stations which show no change in say 5-day extremes suggesting Atmospheric Rivers show no intensification.

John C.

|      |   |    | BLAN | BELL | QUIL | CLEA | ABRD | RAYM | ASTR | TILL | NEWP | FLOR | NOBE |
|------|---|----|------|------|------|------|------|------|------|------|------|------|------|
| 1877 | 1 | 1  |      |      |      |      |      |      | 0.02 |      |      |      |      |
| 1877 | 1 | 2  |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 3  |      |      |      |      |      |      | 1.23 |      |      |      |      |
| 1877 | 1 | 4  |      |      |      |      |      |      | 0.10 |      |      |      |      |
| 1877 | 1 | 5  |      |      |      |      |      |      | 0.12 |      |      |      |      |
| 1877 | 1 | 6  |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 7  |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 8  |      |      |      |      |      |      | 0.23 |      |      |      |      |
| 1877 | 1 | 9  |      |      |      |      |      |      | 0.16 |      |      |      |      |
| 1877 | 1 | 10 |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 11 |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 12 |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 13 |      |      |      |      |      |      | 0.15 |      |      |      |      |
| 1877 | 1 | 14 |      |      |      |      |      |      | 0.05 |      |      |      |      |
| 1877 | 1 | 15 |      |      |      |      |      |      | 0.47 |      |      |      |      |
| 1877 | 1 | 16 |      |      |      |      |      |      | 0.03 |      |      |      |      |
| 1877 | 1 | 17 |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 18 |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 19 |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 20 |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 21 |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 22 |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 23 |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 24 |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 25 |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 26 |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 27 |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 28 |      |      |      |      |      |      | 0.00 |      |      |      |      |
| 1877 | 1 | 29 |      |      |      |      |      |      | 0.02 |      |      |      |      |
| 1877 | 1 | 30 |      |      |      |      |      |      | 0.03 |      |      |      |      |
| 1877 | 1 | 31 |      |      |      |      |      |      | 0.13 |      |      |      |      |
| 1877 | 2 | 1  |      |      |      |      |      |      | 0.40 |      |      |      |      |
| 1877 | 2 | 2  |      |      |      |      |      |      | 0.38 |      |      |      |      |

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|------|---|----|------|
| 1877 | 2 | 3  | 0.04 |
| 1877 | 2 | 4  | 0.00 |
| 1877 | 2 | 5  | 0.05 |
| 1877 | 2 | 6  | 0.00 |
| 1877 | 2 | 7  | 0.02 |
| 1877 | 2 | 8  | 0.39 |
| 1877 | 2 | 9  | 0.02 |
| 1877 | 2 | 10 | 0.00 |
| 1877 | 2 | 11 | 0.47 |
| 1877 | 2 | 12 | 0.49 |
| 1877 | 2 | 13 | 0.29 |
| 1877 | 2 | 14 | 0.00 |
| 1877 | 2 | 15 | 0.00 |
| 1877 | 2 | 16 | 0.00 |
| 1877 | 2 | 17 | 0.00 |
| 1877 | 2 | 18 | 1.17 |
| 1877 | 2 | 19 | 0.40 |
| 1877 | 2 | 20 | 0.12 |
| 1877 | 2 | 21 | 0.30 |
| 1877 | 2 | 22 | 0.10 |
| 1877 | 2 | 23 | 0.09 |
| 1877 | 2 | 24 | 0.00 |
| 1877 | 2 | 25 | 0.02 |
| 1877 | 2 | 26 | 0.02 |
| 1877 | 2 | 27 | 0.20 |
| 1877 | 2 | 28 | 0.06 |
| 1877 | 3 | 1  | 0.00 |
| 1877 | 3 | 2  | 0.00 |
| 1877 | 3 | 3  | 0.00 |
| 1877 | 3 | 4  | 0.36 |
| 1877 | 3 | 5  | 0.30 |
| 1877 | 3 | 6  | 0.09 |
| 1877 | 3 | 7  | 1.05 |
| 1877 | 3 | 8  | 0.37 |
| 1877 | 3 | 9  | 0.06 |
| 1877 | 3 | 10 | 0.11 |
| 1877 | 3 | 11 | 1.24 |
| 1877 | 3 | 12 | 1.42 |
| 1877 | 3 | 13 | 1.19 |
| 1877 | 3 | 14 | 0.21 |
| 1877 | 3 | 15 | 0.03 |
| 1877 | 3 | 16 | 0.09 |
| 1877 | 3 | 17 | 0.00 |

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|------|---|----|------|
| 1877 | 3 | 18 | 0.05 |
| 1877 | 3 | 19 | 0.06 |
| 1877 | 3 | 20 | 0.17 |
| 1877 | 3 | 21 | 0.02 |
| 1877 | 3 | 22 | 0.17 |
| 1877 | 3 | 23 | 1.28 |
| 1877 | 3 | 24 | 0.25 |
| 1877 | 3 | 25 | 0.02 |
| 1877 | 3 | 26 | 0.00 |
| 1877 | 3 | 27 | 0.00 |
| 1877 | 3 | 28 | 0.00 |
| 1877 | 3 | 29 | 0.00 |
| 1877 | 3 | 30 | 0.00 |
| 1877 | 3 | 31 | 0.00 |
| 1877 | 4 | 1  | 0.00 |
| 1877 | 4 | 2  | 0.00 |
| 1877 | 4 | 3  | 0.04 |
| 1877 | 4 | 4  | 0.00 |
| 1877 | 4 | 5  | 0.10 |
| 1877 | 4 | 6  | 0.14 |
| 1877 | 4 | 7  | 0.06 |
| 1877 | 4 | 8  | 0.16 |
| 1877 | 4 | 9  | 0.44 |
| 1877 | 4 | 10 | 0.00 |
| 1877 | 4 | 11 | 0.04 |
| 1877 | 4 | 12 | 0.00 |
| 1877 | 4 | 13 | 0.00 |
| 1877 | 4 | 14 | 0.00 |
| 1877 | 4 | 15 | 0.12 |
| 1877 | 4 | 16 | 0.00 |
| 1877 | 4 | 17 | 0.58 |
| 1877 | 4 | 18 | 0.58 |
| 1877 | 4 | 19 | 0.00 |
| 1877 | 4 | 20 | 0.00 |
| 1877 | 4 | 21 | 0.00 |
| 1877 | 4 | 22 | 0.00 |
| 1877 | 4 | 23 | 0.00 |
| 1877 | 4 | 24 | 0.00 |
| 1877 | 4 | 25 | 0.00 |
| 1877 | 4 | 26 | 0.00 |
| 1877 | 4 | 27 | 0.00 |
| 1877 | 4 | 28 | 0.00 |
| 1877 | 4 | 29 | 0.10 |

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|------|---|----|------|
| 1877 | 4 | 30 | 0.00 |
| 1877 | 5 | 1  | 0.00 |
| 1877 | 5 | 2  | 0.00 |
| 1877 | 5 | 3  | 0.00 |
| 1877 | 5 | 4  | 0.16 |
| 1877 | 5 | 5  | 0.04 |
| 1877 | 5 | 6  | 0.02 |
| 1877 | 5 | 7  | 0.12 |
| 1877 | 5 | 8  | 0.04 |
| 1877 | 5 | 9  | 0.04 |
| 1877 | 5 | 10 | 0.00 |
| 1877 | 5 | 11 | 0.00 |
| 1877 | 5 | 12 | 0.00 |
| 1877 | 5 | 13 | 0.00 |
| 1877 | 5 | 14 | 0.00 |
| 1877 | 5 | 15 | 0.00 |
| 1877 | 5 | 16 | 0.02 |
| 1877 | 5 | 17 | 0.00 |
| 1877 | 5 | 18 | 0.16 |
| 1877 | 5 | 19 | 0.24 |
| 1877 | 5 | 20 | 0.00 |
| 1877 | 5 | 21 | 0.00 |
| 1877 | 5 | 22 | 0.00 |
| 1877 | 5 | 23 | 0.00 |
| 1877 | 5 | 24 | 0.00 |
| 1877 | 5 | 25 | 0.18 |
| 1877 | 5 | 26 | 0.14 |
| 1877 | 5 | 27 | 0.08 |
| 1877 | 5 | 28 | 0.00 |
| 1877 | 5 | 29 | 0.02 |
| 1877 | 5 | 30 | 0.00 |
| 1877 | 5 | 31 | 0.00 |
| 1877 | 6 | 1  | 0.08 |
| 1877 | 6 | 2  | 0.06 |
| 1877 | 6 | 3  | 0.24 |
| 1877 | 6 | 4  | 0.60 |
| 1877 | 6 | 5  | 0.06 |
| 1877 | 6 | 6  | 0.00 |
| 1877 | 6 | 7  | 0.00 |
| 1877 | 6 | 8  | 0.00 |
| 1877 | 6 | 9  | 0.00 |
| 1877 | 6 | 10 | 0.00 |
| 1877 | 6 | 11 | 0.00 |

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|------|---|----|------|
| 1877 | 6 | 12 | 0.00 |
| 1877 | 6 | 13 | 0.00 |
| 1877 | 6 | 14 | 0.00 |
| 1877 | 6 | 15 | 0.00 |
| 1877 | 6 | 16 | 0.06 |
| 1877 | 6 | 17 | 0.00 |
| 1877 | 6 | 18 | 0.00 |
| 1877 | 6 | 19 | 0.00 |
| 1877 | 6 | 20 | 0.00 |
| 1877 | 6 | 21 | 0.44 |
| 1877 | 6 | 22 | 0.18 |
| 1877 | 6 | 23 | 0.62 |
| 1877 | 6 | 24 | 0.00 |
| 1877 | 6 | 25 | 0.00 |
| 1877 | 6 | 26 | 0.00 |
| 1877 | 6 | 27 | 0.00 |
| 1877 | 6 | 28 | 0.24 |
| 1877 | 6 | 29 | 0.14 |
| 1877 | 6 | 30 | 0.00 |
| 1877 | 7 | 1  | 0.60 |
| 1877 | 7 | 2  | 0.10 |
| 1877 | 7 | 3  | 0.28 |
| 1877 | 7 | 4  | 0.00 |
| 1877 | 7 | 5  | 0.00 |
| 1877 | 7 | 6  | 0.00 |
| 1877 | 7 | 7  | 0.00 |
| 1877 | 7 | 8  | 0.00 |
| 1877 | 7 | 9  | 0.00 |
| 1877 | 7 | 10 | 0.12 |
| 1877 | 7 | 11 | 0.00 |
| 1877 | 7 | 12 | 0.00 |
| 1877 | 7 | 13 | 0.00 |
| 1877 | 7 | 14 | 0.00 |
| 1877 | 7 | 15 | 0.00 |
| 1877 | 7 | 16 | 0.00 |
| 1877 | 7 | 17 | 0.00 |
| 1877 | 7 | 18 | 0.00 |
| 1877 | 7 | 19 | 0.00 |
| 1877 | 7 | 20 | 0.00 |
| 1877 | 7 | 21 | 0.12 |
| 1877 | 7 | 22 | 0.00 |
| 1877 | 7 | 23 | 0.00 |
| 1877 | 7 | 24 | 0.10 |

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|------|---|----|------|
| 1877 | 7 | 25 | 0.08 |
| 1877 | 7 | 26 | 0.00 |
| 1877 | 7 | 27 | 0.00 |
| 1877 | 7 | 28 | 0.00 |
| 1877 | 7 | 29 | 0.00 |
| 1877 | 7 | 30 | 0.26 |
| 1877 | 7 | 31 | 0.06 |
| 1877 | 8 | 1  | 0.14 |
| 1877 | 8 | 2  | 0.10 |
| 1877 | 8 | 3  | 0.08 |
| 1877 | 8 | 4  | 0.00 |
| 1877 | 8 | 5  | 0.00 |
| 1877 | 8 | 6  | 0.00 |
| 1877 | 8 | 7  | 0.00 |
| 1877 | 8 | 8  | 0.00 |
| 1877 | 8 | 9  | 0.00 |
| 1877 | 8 | 10 | 0.00 |
| 1877 | 8 | 11 | 0.00 |
| 1877 | 8 | 12 | 0.04 |
| 1877 | 8 | 13 | 0.04 |
| 1877 | 8 | 14 | 0.00 |
| 1877 | 8 | 15 | 0.00 |
| 1877 | 8 | 16 | 0.04 |
| 1877 | 8 | 17 | 0.00 |
| 1877 | 8 | 18 | 0.04 |
| 1877 | 8 | 19 | 0.04 |
| 1877 | 8 | 20 | 0.00 |
| 1877 | 8 | 21 | 0.04 |
| 1877 | 8 | 22 | 0.04 |
| 1877 | 8 | 23 | 2.10 |
| 1877 | 8 | 24 | 0.90 |
| 1877 | 8 | 25 | 0.00 |
| 1877 | 8 | 26 | 0.00 |
| 1877 | 8 | 27 | 0.00 |
| 1877 | 8 | 28 | 0.00 |
| 1877 | 8 | 29 | 0.04 |
| 1877 | 8 | 30 | 0.00 |
| 1877 | 8 | 31 | 0.00 |
| 1877 | 9 | 1  | 0.00 |
| 1877 | 9 | 2  | 0.02 |
| 1877 | 9 | 3  | 0.00 |
| 1877 | 9 | 4  | 0.00 |
| 1877 | 9 | 5  | 0.02 |



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|------|----|----|------|
| 1877 | 9  | 6  | 0.00 |
| 1877 | 9  | 7  | 0.14 |
| 1877 | 9  | 8  | 0.09 |
| 1877 | 9  | 9  | 0.22 |
| 1877 | 9  | 10 | 0.34 |
| 1877 | 9  | 11 | 0.04 |
| 1877 | 9  | 12 | 0.10 |
| 1877 | 9  | 13 | 0.21 |
| 1877 | 9  | 14 | 0.14 |
| 1877 | 9  | 15 | 0.00 |
| 1877 | 9  | 16 | 0.00 |
| 1877 | 9  | 17 | 0.00 |
| 1877 | 9  | 18 | 0.00 |
| 1877 | 9  | 19 | 0.14 |
| 1877 | 9  | 20 | 0.05 |
| 1877 | 9  | 21 | 0.00 |
| 1877 | 9  | 22 | 0.34 |
| 1877 | 9  | 23 | 0.14 |
| 1877 | 9  | 24 | 0.35 |
| 1877 | 9  | 25 | 0.22 |
| 1877 | 9  | 26 | 1.00 |
| 1877 | 9  | 27 | 1.04 |
| 1877 | 9  | 28 | 0.13 |
| 1877 | 9  | 29 | 0.00 |
| 1877 | 9  | 30 | 0.48 |
| 1877 | 10 | 1  | 0.44 |
| 1877 | 10 | 2  | 0.00 |
| 1877 | 10 | 3  | 0.80 |
| 1877 | 10 | 4  | 0.26 |
| 1877 | 10 | 5  | 0.32 |
| 1877 | 10 | 6  | 0.64 |
| 1877 | 10 | 7  | 0.00 |
| 1877 | 10 | 8  | 0.00 |
| 1877 | 10 | 9  | 0.78 |
| 1877 | 10 | 10 | 0.00 |
| 1877 | 10 | 11 | 0.00 |
| 1877 | 10 | 12 | 0.00 |
| 1877 | 10 | 13 | 0.00 |
| 1877 | 10 | 14 | 0.00 |
| 1877 | 10 | 15 | 0.00 |
| 1877 | 10 | 16 | 0.00 |
| 1877 | 10 | 17 | 0.00 |
| 1877 | 10 | 18 | 0.00 |

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|------|----|----|------|
| 1877 | 10 | 19 | 0.00 |
| 1877 | 10 | 20 | 0.00 |
| 1877 | 10 | 21 | 0.06 |
| 1877 | 10 | 22 | 0.48 |
| 1877 | 10 | 23 | 0.66 |
| 1877 | 10 | 24 | 0.94 |
| 1877 | 10 | 25 | 0.56 |
| 1877 | 10 | 26 | 0.06 |
| 1877 | 10 | 27 | 0.00 |
| 1877 | 10 | 28 | 0.00 |
| 1877 | 10 | 29 | 0.00 |
| 1877 | 10 | 30 | 0.00 |
| 1877 | 10 | 31 | 0.00 |
| 1877 | 11 | 1  | 0.00 |
| 1877 | 11 | 2  | 0.42 |
| 1877 | 11 | 3  | 0.07 |
| 1877 | 11 | 4  | 2.14 |
| 1877 | 11 | 5  | 0.06 |
| 1877 | 11 | 6  | 0.21 |
| 1877 | 11 | 7  | 0.07 |
| 1877 | 11 | 8  | 0.13 |
| 1877 | 11 | 9  | 0.07 |
| 1877 | 11 | 10 | 0.38 |
| 1877 | 11 | 11 | 0.33 |
| 1877 | 11 | 12 | 0.18 |
| 1877 | 11 | 13 | 0.12 |
| 1877 | 11 | 14 | 0.43 |
| 1877 | 11 | 15 | 1.13 |
| 1877 | 11 | 16 | 0.20 |
| 1877 | 11 | 17 | 2.42 |
| 1877 | 11 | 18 | 0.28 |
| 1877 | 11 | 19 | 0.08 |
| 1877 | 11 | 20 | 0.11 |
| 1877 | 11 | 21 | 1.30 |
| 1877 | 11 | 22 | 0.27 |
| 1877 | 11 | 23 | 1.17 |
| 1877 | 11 | 24 | 1.09 |
| 1877 | 11 | 25 | 0.00 |
| 1877 | 11 | 26 | 0.00 |
| 1877 | 11 | 27 | 0.00 |
| 1877 | 11 | 28 | 0.00 |
| 1877 | 11 | 29 | 0.14 |
| 1877 | 11 | 30 | 0.00 |

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|------|----|----|------|
| 1877 | 12 | 1  | 0.04 |
| 1877 | 12 | 2  | 0.52 |
| 1877 | 12 | 3  | 0.16 |
| 1877 | 12 | 4  | 0.10 |
| 1877 | 12 | 5  | 0.54 |
| 1877 | 12 | 6  | 0.06 |
| 1877 | 12 | 7  | 0.24 |
| 1877 | 12 | 8  | 0.82 |
| 1877 | 12 | 9  | 2.48 |
| 1877 | 12 | 10 | 2.10 |
| 1877 | 12 | 11 | 0.38 |
| 1877 | 12 | 12 | 0.00 |
| 1877 | 12 | 13 | 0.00 |
| 1877 | 12 | 14 | 0.10 |
| 1877 | 12 | 15 | 0.08 |
| 1877 | 12 | 16 | 0.40 |
| 1877 | 12 | 17 | 0.12 |
| 1877 | 12 | 18 | 0.00 |
| 1877 | 12 | 19 | 0.18 |
| 1877 | 12 | 20 | 0.72 |
| 1877 | 12 | 21 | 0.16 |
| 1877 | 12 | 22 | 0.22 |
| 1877 | 12 | 23 | 0.00 |
| 1877 | 12 | 24 | 0.00 |
| 1877 | 12 | 25 | 0.08 |
| 1877 | 12 | 26 | 0.06 |
| 1877 | 12 | 27 | 0.00 |
| 1877 | 12 | 28 | 0.00 |
| 1877 | 12 | 29 | 0.00 |
| 1877 | 12 | 30 | 0.00 |
| 1877 | 12 | 31 | 0.00 |
| 1878 | 1  | 1  | 0.06 |
| 1878 | 1  | 2  | 0.00 |
| 1878 | 1  | 3  | 0.00 |
| 1878 | 1  | 4  | 0.00 |
| 1878 | 1  | 5  | 0.00 |
| 1878 | 1  | 6  | 0.04 |
| 1878 | 1  | 7  | 0.92 |
| 1878 | 1  | 8  | 0.48 |
| 1878 | 1  | 9  | 0.86 |
| 1878 | 1  | 10 | 0.28 |
| 1878 | 1  | 11 | 0.04 |
| 1878 | 1  | 12 | 0.00 |

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|------|---|----|------|
| 1878 | 1 | 13 | 0.00 |
| 1878 | 1 | 14 | 0.36 |
| 1878 | 1 | 15 | 0.38 |
| 1878 | 1 | 16 | 0.16 |
| 1878 | 1 | 17 | 0.36 |
| 1878 | 1 | 18 | 0.76 |
| 1878 | 1 | 19 | 0.06 |
| 1878 | 1 | 20 | 0.00 |
| 1878 | 1 | 21 | 0.48 |
| 1878 | 1 | 22 | 0.64 |
| 1878 | 1 | 23 | 0.24 |
| 1878 | 1 | 24 | 0.44 |
| 1878 | 1 | 25 | 0.10 |
| 1878 | 1 | 26 | 0.30 |
| 1878 | 1 | 27 | 0.92 |
| 1878 | 1 | 28 | 0.70 |
| 1878 | 1 | 29 | 0.76 |
| 1878 | 1 | 30 | 2.10 |
| 1878 | 1 | 31 | 0.36 |
| 1878 | 2 | 1  | 1.04 |
| 1878 | 2 | 2  | 0.25 |
| 1878 | 2 | 3  | 2.15 |
| 1878 | 2 | 4  | 0.30 |
| 1878 | 2 | 5  | 0.13 |
| 1878 | 2 | 6  | 0.40 |
| 1878 | 2 | 7  | 0.35 |
| 1878 | 2 | 8  | 0.08 |
| 1878 | 2 | 9  | 1.05 |
| 1878 | 2 | 10 | 0.48 |
| 1878 | 2 | 11 | 0.31 |
| 1878 | 2 | 12 | 0.19 |
| 1878 | 2 | 13 | 0.14 |
| 1878 | 2 | 14 | 0.24 |
| 1878 | 2 | 15 | 0.00 |
| 1878 | 2 | 16 | 0.35 |
| 1878 | 2 | 17 | 0.20 |
| 1878 | 2 | 18 | 0.35 |
| 1878 | 2 | 19 | 0.20 |
| 1878 | 2 | 20 | 0.00 |
| 1878 | 2 | 21 | 0.00 |
| 1878 | 2 | 22 | 0.07 |
| 1878 | 2 | 23 | 0.08 |
| 1878 | 2 | 24 | 0.02 |

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|------|---|----|------|
| 1878 | 2 | 25 | 0.10 |
| 1878 | 2 | 26 | 0.21 |
| 1878 | 2 | 27 | 0.00 |
| 1878 | 2 | 28 | 0.28 |
| 1878 | 3 | 1  | 0.00 |
| 1878 | 3 | 2  | 0.00 |
| 1878 | 3 | 3  | 0.24 |
| 1878 | 3 | 4  | 0.49 |
| 1878 | 3 | 5  | 1.05 |
| 1878 | 3 | 6  | 0.32 |
| 1878 | 3 | 7  | 0.11 |
| 1878 | 3 | 8  | 0.00 |
| 1878 | 3 | 9  | 0.10 |
| 1878 | 3 | 10 | 0.00 |
| 1878 | 3 | 11 | 0.07 |
| 1878 | 3 | 12 | 0.02 |
| 1878 | 3 | 13 | 0.17 |
| 1878 | 3 | 14 | 0.36 |
| 1878 | 3 | 15 | 0.20 |
| 1878 | 3 | 16 | 0.28 |
| 1878 | 3 | 17 | 0.10 |
| 1878 | 3 | 18 | 0.03 |
| 1878 | 3 | 19 | 0.00 |
| 1878 | 3 | 20 | 0.00 |
| 1878 | 3 | 21 | 0.00 |
| 1878 | 3 | 22 | 0.00 |
| 1878 | 3 | 23 | 0.15 |
| 1878 | 3 | 24 | 0.00 |
| 1878 | 3 | 25 | 0.12 |
| 1878 | 3 | 26 | 0.00 |
| 1878 | 3 | 27 | 0.00 |
| 1878 | 3 | 28 | 0.10 |
| 1878 | 3 | 29 | 0.00 |
| 1878 | 3 | 30 | 0.07 |
| 1878 | 3 | 31 | 0.00 |
| 1878 | 4 | 1  | 0.00 |
| 1878 | 4 | 2  | 0.00 |
| 1878 | 4 | 3  | 0.00 |
| 1878 | 4 | 4  | 0.00 |
| 1878 | 4 | 5  | 0.00 |
| 1878 | 4 | 6  | 0.12 |
| 1878 | 4 | 7  | 0.16 |
| 1878 | 4 | 8  | 0.00 |

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|------|---|----|------|
| 1878 | 4 | 9  | 0.00 |
| 1878 | 4 | 10 | 0.16 |
| 1878 | 4 | 11 | 0.12 |
| 1878 | 4 | 12 | 1.48 |
| 1878 | 4 | 13 | 0.00 |
| 1878 | 4 | 14 | 0.00 |
| 1878 | 4 | 15 | 0.00 |
| 1878 | 4 | 16 | 0.00 |
| 1878 | 4 | 17 | 0.00 |
| 1878 | 4 | 18 | 0.44 |
| 1878 | 4 | 19 | 0.24 |
| 1878 | 4 | 20 | 0.60 |
| 1878 | 4 | 21 | 0.00 |
| 1878 | 4 | 22 | 0.00 |
| 1878 | 4 | 23 | 0.00 |
| 1878 | 4 | 24 | 0.40 |
| 1878 | 4 | 25 | 0.20 |
| 1878 | 4 | 26 | 0.00 |
| 1878 | 4 | 27 | 0.44 |
| 1878 | 4 | 28 | 0.00 |
| 1878 | 4 | 29 | 0.00 |
| 1878 | 4 | 30 | 0.36 |
| 1878 | 5 | 1  | 0.00 |
| 1878 | 5 | 2  | 0.00 |
| 1878 | 5 | 3  | 0.00 |
| 1878 | 5 | 4  | 0.00 |
| 1878 | 5 | 5  | 0.28 |
| 1878 | 5 | 6  | 0.00 |
| 1878 | 5 | 7  | 0.00 |
| 1878 | 5 | 8  | 0.00 |
| 1878 | 5 | 9  | 0.10 |
| 1878 | 5 | 10 | 0.00 |
| 1878 | 5 | 11 | 0.16 |
| 1878 | 5 | 12 | 0.00 |
| 1878 | 5 | 13 | 0.12 |
| 1878 | 5 | 14 | 0.10 |
| 1878 | 5 | 15 | 0.00 |
| 1878 | 5 | 16 | 0.08 |
| 1878 | 5 | 17 | 0.00 |
| 1878 | 5 | 18 | 0.44 |
| 1878 | 5 | 19 | 0.14 |
| 1878 | 5 | 20 | 0.00 |
| 1878 | 5 | 21 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1878 | 5 | 22 | 0.00 |
| 1878 | 5 | 23 | 0.00 |
| 1878 | 5 | 24 | 0.00 |
| 1878 | 5 | 25 | 0.00 |
| 1878 | 5 | 26 | 0.50 |
| 1878 | 5 | 27 | 0.68 |
| 1878 | 5 | 28 | 0.00 |
| 1878 | 5 | 29 | 0.00 |
| 1878 | 5 | 30 | 0.08 |
| 1878 | 5 | 31 | 0.00 |
| 1878 | 6 | 1  | 0.16 |
| 1878 | 6 | 2  | 0.00 |
| 1878 | 6 | 3  | 0.00 |
| 1878 | 6 | 4  | 0.00 |
| 1878 | 6 | 5  | 0.00 |
| 1878 | 6 | 6  | 0.00 |
| 1878 | 6 | 7  | 0.00 |
| 1878 | 6 | 8  | 0.00 |
| 1878 | 6 | 9  | 0.00 |
| 1878 | 6 | 10 | 0.00 |
| 1878 | 6 | 11 | 0.00 |
| 1878 | 6 | 12 | 0.00 |
| 1878 | 6 | 13 | 0.00 |
| 1878 | 6 | 14 | 0.00 |
| 1878 | 6 | 15 | 0.00 |
| 1878 | 6 | 16 | 0.00 |
| 1878 | 6 | 17 | 0.00 |
| 1878 | 6 | 18 | 0.00 |
| 1878 | 6 | 19 | 0.00 |
| 1878 | 6 | 20 | 0.00 |
| 1878 | 6 | 21 | 0.08 |
| 1878 | 6 | 22 | 0.00 |
| 1878 | 6 | 23 | 0.18 |
| 1878 | 6 | 24 | 0.00 |
| 1878 | 6 | 25 | 0.00 |
| 1878 | 6 | 26 | 0.16 |
| 1878 | 6 | 27 | 0.00 |
| 1878 | 6 | 28 | 0.00 |
| 1878 | 6 | 29 | 0.00 |
| 1878 | 6 | 30 | 0.00 |
| 1878 | 7 | 1  | 0.14 |
| 1878 | 7 | 2  | 0.30 |
| 1878 | 7 | 3  | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1878 | 7 | 4  | 0.14 |
| 1878 | 7 | 5  | 0.08 |
| 1878 | 7 | 6  | 0.00 |
| 1878 | 7 | 7  | 0.00 |
| 1878 | 7 | 8  | 0.00 |
| 1878 | 7 | 9  | 0.00 |
| 1878 | 7 | 10 | 0.28 |
| 1878 | 7 | 11 | 0.00 |
| 1878 | 7 | 12 | 0.00 |
| 1878 | 7 | 13 | 0.00 |
| 1878 | 7 | 14 | 0.00 |
| 1878 | 7 | 15 | 0.00 |
| 1878 | 7 | 16 | 0.00 |
| 1878 | 7 | 17 | 0.90 |
| 1878 | 7 | 18 | 0.00 |
| 1878 | 7 | 19 | 0.00 |
| 1878 | 7 | 20 | 0.00 |
| 1878 | 7 | 21 | 0.10 |
| 1878 | 7 | 22 | 0.00 |
| 1878 | 7 | 23 | 0.00 |
| 1878 | 7 | 24 | 0.00 |
| 1878 | 7 | 25 | 0.00 |
| 1878 | 7 | 26 | 0.00 |
| 1878 | 7 | 27 | 0.00 |
| 1878 | 7 | 28 | 0.00 |
| 1878 | 7 | 29 | 0.00 |
| 1878 | 7 | 30 | 0.00 |
| 1878 | 7 | 31 | 0.00 |
| 1878 | 8 | 1  | 0.14 |
| 1878 | 8 | 2  | 0.00 |
| 1878 | 8 | 3  | 0.00 |
| 1878 | 8 | 4  | 0.00 |
| 1878 | 8 | 5  | 0.28 |
| 1878 | 8 | 6  | 0.00 |
| 1878 | 8 | 7  | 0.00 |
| 1878 | 8 | 8  | 0.08 |
| 1878 | 8 | 9  | 0.00 |
| 1878 | 8 | 10 | 0.00 |
| 1878 | 8 | 11 | 0.00 |
| 1878 | 8 | 12 | 0.00 |
| 1878 | 8 | 13 | 0.00 |
| 1878 | 8 | 14 | 0.00 |
| 1878 | 8 | 15 | 0.00 |



|      |   |    |      |
|------|---|----|------|
| 1878 | 8 | 16 | 0.14 |
| 1878 | 8 | 17 | 0.10 |
| 1878 | 8 | 18 | 0.00 |
| 1878 | 8 | 19 | 0.00 |
| 1878 | 8 | 20 | 0.00 |
| 1878 | 8 | 21 | 0.00 |
| 1878 | 8 | 22 | 0.08 |
| 1878 | 8 | 23 | 0.00 |
| 1878 | 8 | 24 | 0.14 |
| 1878 | 8 | 25 | 0.00 |
| 1878 | 8 | 26 | 0.00 |
| 1878 | 8 | 27 | 0.00 |
| 1878 | 8 | 28 | 0.00 |
| 1878 | 8 | 29 | 0.18 |
| 1878 | 8 | 30 | 0.00 |
| 1878 | 8 | 31 | 0.00 |
| 1878 | 9 | 1  | 0.00 |
| 1878 | 9 | 2  | 0.18 |
| 1878 | 9 | 3  | 0.00 |
| 1878 | 9 | 4  | 0.00 |
| 1878 | 9 | 5  | 0.00 |
| 1878 | 9 | 6  | 0.00 |
| 1878 | 9 | 7  | 0.00 |
| 1878 | 9 | 8  | 0.00 |
| 1878 | 9 | 9  | 0.00 |
| 1878 | 9 | 10 | 0.00 |
| 1878 | 9 | 11 | 0.00 |
| 1878 | 9 | 12 | 0.00 |
| 1878 | 9 | 13 | 0.00 |
| 1878 | 9 | 14 | 0.00 |
| 1878 | 9 | 15 | 0.00 |
| 1878 | 9 | 16 | 0.00 |
| 1878 | 9 | 17 | 0.00 |
| 1878 | 9 | 18 | 0.00 |
| 1878 | 9 | 19 | 0.00 |
| 1878 | 9 | 20 | 0.00 |
| 1878 | 9 | 21 | 0.00 |
| 1878 | 9 | 22 | 0.18 |
| 1878 | 9 | 23 | 0.00 |
| 1878 | 9 | 24 | 0.94 |
| 1878 | 9 | 25 | 0.10 |
| 1878 | 9 | 26 | 0.00 |
| 1878 | 9 | 27 | 0.70 |

|      |    |    |      |
|------|----|----|------|
| 1878 | 9  | 28 | 0.94 |
| 1878 | 9  | 29 | 0.80 |
| 1878 | 9  | 30 | 1.72 |
| 1878 | 10 | 1  | 0.44 |
| 1878 | 10 | 2  | 0.34 |
| 1878 | 10 | 3  | 0.00 |
| 1878 | 10 | 4  | 0.00 |
| 1878 | 10 | 5  | 0.00 |
| 1878 | 10 | 6  | 0.00 |
| 1878 | 10 | 7  | 0.22 |
| 1878 | 10 | 8  | 0.00 |
| 1878 | 10 | 9  | 0.56 |
| 1878 | 10 | 10 | 0.20 |
| 1878 | 10 | 11 | 0.10 |
| 1878 | 10 | 12 | 0.00 |
| 1878 | 10 | 13 | 1.80 |
| 1878 | 10 | 14 | 0.10 |
| 1878 | 10 | 15 | 0.00 |
| 1878 | 10 | 16 | 0.20 |
| 1878 | 10 | 17 | 0.00 |
| 1878 | 10 | 18 | 0.00 |
| 1878 | 10 | 19 | 0.00 |
| 1878 | 10 | 20 | 0.00 |
| 1878 | 10 | 21 | 0.60 |
| 1878 | 10 | 22 | 0.00 |
| 1878 | 10 | 23 | 0.00 |
| 1878 | 10 | 24 | 0.00 |
| 1878 | 10 | 25 | 0.00 |
| 1878 | 10 | 26 | 0.00 |
| 1878 | 10 | 27 | 0.00 |
| 1878 | 10 | 28 | 0.00 |
| 1878 | 10 | 29 | 0.00 |
| 1878 | 10 | 30 | 0.00 |
| 1878 | 10 | 31 | 0.00 |
| 1878 | 11 | 1  | 0.00 |
| 1878 | 11 | 2  | 0.00 |
| 1878 | 11 | 3  | 0.00 |
| 1878 | 11 | 4  | 0.36 |
| 1878 | 11 | 5  | 0.00 |
| 1878 | 11 | 6  | 0.00 |
| 1878 | 11 | 7  | 0.00 |
| 1878 | 11 | 8  | 0.00 |
| 1878 | 11 | 9  | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1878 | 11 | 10 | 0.00 |
| 1878 | 11 | 11 | 0.00 |
| 1878 | 11 | 12 | 0.00 |
| 1878 | 11 | 13 | 0.34 |
| 1878 | 11 | 14 | 0.70 |
| 1878 | 11 | 15 | 0.00 |
| 1878 | 11 | 16 | 2.68 |
| 1878 | 11 | 17 | 1.10 |
| 1878 | 11 | 18 | 0.30 |
| 1878 | 11 | 19 | 0.76 |
| 1878 | 11 | 20 | 0.30 |
| 1878 | 11 | 21 | 0.20 |
| 1878 | 11 | 22 | 0.90 |
| 1878 | 11 | 23 | 0.00 |
| 1878 | 11 | 24 | 0.00 |
| 1878 | 11 | 25 | 0.00 |
| 1878 | 11 | 26 | 0.00 |
| 1878 | 11 | 27 | 0.16 |
| 1878 | 11 | 28 | 0.24 |
| 1878 | 11 | 29 | 0.32 |
| 1878 | 11 | 30 | 0.00 |
| 1878 | 12 | 1  | 2.72 |
| 1878 | 12 | 2  | 0.04 |
| 1878 | 12 | 3  | 0.26 |
| 1878 | 12 | 4  | 0.00 |
| 1878 | 12 | 5  | 0.00 |
| 1878 | 12 | 6  | 0.46 |
| 1878 | 12 | 7  | 0.24 |
| 1878 | 12 | 8  | 0.74 |
| 1878 | 12 | 9  | 0.56 |
| 1878 | 12 | 10 | 0.36 |
| 1878 | 12 | 11 | 0.00 |
| 1878 | 12 | 12 | 0.00 |
| 1878 | 12 | 13 | 0.00 |
| 1878 | 12 | 14 | 0.00 |
| 1878 | 12 | 15 | 0.00 |
| 1878 | 12 | 16 | 0.00 |
| 1878 | 12 | 17 | 0.20 |
| 1878 | 12 | 18 | 0.00 |
| 1878 | 12 | 19 | 0.00 |
| 1878 | 12 | 20 | 0.00 |
| 1878 | 12 | 21 | 0.00 |
| 1878 | 12 | 22 | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1878 | 12 | 23 | 0.00 |
| 1878 | 12 | 24 | 0.00 |
| 1878 | 12 | 25 | 0.00 |
| 1878 | 12 | 26 | 0.00 |
| 1878 | 12 | 27 | 0.00 |
| 1878 | 12 | 28 | 0.00 |
| 1878 | 12 | 29 | 0.00 |
| 1878 | 12 | 30 | 0.00 |
| 1878 | 12 | 31 | 0.00 |
| 1879 | 1  | 1  | 0.00 |
| 1879 | 1  | 2  | 0.00 |
| 1879 | 1  | 3  | 0.26 |
| 1879 | 1  | 4  | 0.00 |
| 1879 | 1  | 5  | 0.24 |
| 1879 | 1  | 6  | 0.00 |
| 1879 | 1  | 7  | 0.00 |
| 1879 | 1  | 8  | 0.56 |
| 1879 | 1  | 9  | 0.20 |
| 1879 | 1  | 10 | 1.34 |
| 1879 | 1  | 11 | 0.20 |
| 1879 | 1  | 12 | 0.48 |
| 1879 | 1  | 13 | 0.54 |
| 1879 | 1  | 14 | 0.00 |
| 1879 | 1  | 15 | 0.38 |
| 1879 | 1  | 16 | 0.92 |
| 1879 | 1  | 17 | 0.00 |
| 1879 | 1  | 18 | 0.00 |
| 1879 | 1  | 19 | 0.42 |
| 1879 | 1  | 20 | 0.28 |
| 1879 | 1  | 21 | 0.00 |
| 1879 | 1  | 22 | 0.00 |
| 1879 | 1  | 23 | 0.88 |
| 1879 | 1  | 24 | 0.00 |
| 1879 | 1  | 25 | 0.96 |
| 1879 | 1  | 26 | 0.06 |
| 1879 | 1  | 27 | 0.32 |
| 1879 | 1  | 28 | 0.20 |
| 1879 | 1  | 29 | 0.00 |
| 1879 | 1  | 30 | 0.00 |
| 1879 | 1  | 31 | 0.00 |
| 1879 | 2  | 1  | 0.00 |
| 1879 | 2  | 2  | 0.00 |
| 1879 | 2  | 3  | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1879 | 2 | 4  | 0.00 |
| 1879 | 2 | 5  | 0.00 |
| 1879 | 2 | 6  | 0.14 |
| 1879 | 2 | 7  | 0.16 |
| 1879 | 2 | 8  | 0.26 |
| 1879 | 2 | 9  | 0.48 |
| 1879 | 2 | 10 | 0.00 |
| 1879 | 2 | 11 | 0.94 |
| 1879 | 2 | 12 | 0.86 |
| 1879 | 2 | 13 | 0.26 |
| 1879 | 2 | 14 | 0.50 |
| 1879 | 2 | 15 | 0.36 |
| 1879 | 2 | 16 | 0.36 |
| 1879 | 2 | 17 | 1.48 |
| 1879 | 2 | 18 | 0.18 |
| 1879 | 2 | 19 | 1.30 |
| 1879 | 2 | 20 | 0.70 |
| 1879 | 2 | 21 | 0.22 |
| 1879 | 2 | 22 | 0.10 |
| 1879 | 2 | 23 | 1.30 |
| 1879 | 2 | 24 | 1.60 |
| 1879 | 2 | 25 | 0.00 |
| 1879 | 2 | 26 | 2.00 |
| 1879 | 2 | 27 | 2.20 |
| 1879 | 2 | 28 | 0.00 |
| 1879 | 3 | 1  | 0.00 |
| 1879 | 3 | 2  | 0.16 |
| 1879 | 3 | 3  | 0.32 |
| 1879 | 3 | 4  | 0.64 |
| 1879 | 3 | 5  | 0.52 |
| 1879 | 3 | 6  | 0.30 |
| 1879 | 3 | 7  | 0.34 |
| 1879 | 3 | 8  | 0.44 |
| 1879 | 3 | 9  | 0.34 |
| 1879 | 3 | 10 | 0.66 |
| 1879 | 3 | 11 | 0.90 |
| 1879 | 3 | 12 | 0.20 |
| 1879 | 3 | 13 | 0.00 |
| 1879 | 3 | 14 | 0.00 |
| 1879 | 3 | 15 | 0.10 |
| 1879 | 3 | 16 | 0.00 |
| 1879 | 3 | 17 | 0.00 |
| 1879 | 3 | 18 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1879 | 3 | 19 | 0.10 |
| 1879 | 3 | 20 | 0.20 |
| 1879 | 3 | 21 | 0.20 |
| 1879 | 3 | 22 | 0.00 |
| 1879 | 3 | 23 | 0.28 |
| 1879 | 3 | 24 | 1.60 |
| 1879 | 3 | 25 | 0.40 |
| 1879 | 3 | 26 | 1.00 |
| 1879 | 3 | 27 | 0.30 |
| 1879 | 3 | 28 | 0.76 |
| 1879 | 3 | 29 | 1.16 |
| 1879 | 3 | 30 | 0.00 |
| 1879 | 3 | 31 | 0.00 |
| 1879 | 4 | 1  | 0.00 |
| 1879 | 4 | 2  | 0.00 |
| 1879 | 4 | 3  | 0.00 |
| 1879 | 4 | 4  | 0.00 |
| 1879 | 4 | 5  | 0.00 |
| 1879 | 4 | 6  | 0.00 |
| 1879 | 4 | 7  | 0.14 |
| 1879 | 4 | 8  | 0.42 |
| 1879 | 4 | 9  | 0.72 |
| 1879 | 4 | 10 | 0.22 |
| 1879 | 4 | 11 | 0.10 |
| 1879 | 4 | 12 | 0.00 |
| 1879 | 4 | 13 | 0.56 |
| 1879 | 4 | 14 | 0.32 |
| 1879 | 4 | 15 | 0.06 |
| 1879 | 4 | 16 | 0.04 |
| 1879 | 4 | 17 | 0.00 |
| 1879 | 4 | 18 | 0.00 |
| 1879 | 4 | 19 | 0.00 |
| 1879 | 4 | 20 | 0.06 |
| 1879 | 4 | 21 | 0.00 |
| 1879 | 4 | 22 | 0.00 |
| 1879 | 4 | 23 | 0.00 |
| 1879 | 4 | 24 | 0.00 |
| 1879 | 4 | 25 | 0.00 |
| 1879 | 4 | 26 | 0.00 |
| 1879 | 4 | 27 | 0.00 |
| 1879 | 4 | 28 | 0.00 |
| 1879 | 4 | 29 | 0.00 |
| 1879 | 4 | 30 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1879 | 5 | 1  | 0.60 |
| 1879 | 5 | 2  | 0.20 |
| 1879 | 5 | 3  | 0.14 |
| 1879 | 5 | 4  | 0.06 |
| 1879 | 5 | 5  | 0.00 |
| 1879 | 5 | 6  | 0.22 |
| 1879 | 5 | 7  | 0.16 |
| 1879 | 5 | 8  | 0.00 |
| 1879 | 5 | 9  | 0.00 |
| 1879 | 5 | 10 | 0.00 |
| 1879 | 5 | 11 | 0.40 |
| 1879 | 5 | 12 | 0.16 |
| 1879 | 5 | 13 | 0.00 |
| 1879 | 5 | 14 | 0.32 |
| 1879 | 5 | 15 | 0.16 |
| 1879 | 5 | 16 | 0.04 |
| 1879 | 5 | 17 | 0.00 |
| 1879 | 5 | 18 | 0.16 |
| 1879 | 5 | 19 | 0.00 |
| 1879 | 5 | 20 | 0.40 |
| 1879 | 5 | 21 | 0.00 |
| 1879 | 5 | 22 | 0.00 |
| 1879 | 5 | 23 | 0.12 |
| 1879 | 5 | 24 | 0.04 |
| 1879 | 5 | 25 | 0.00 |
| 1879 | 5 | 26 | 0.00 |
| 1879 | 5 | 27 | 0.16 |
| 1879 | 5 | 28 | 0.12 |
| 1879 | 5 | 29 | 0.18 |
| 1879 | 5 | 30 | 0.12 |
| 1879 | 5 | 31 | 0.00 |
| 1879 | 6 | 1  | 0.00 |
| 1879 | 6 | 2  | 0.00 |
| 1879 | 6 | 3  | 0.00 |
| 1879 | 6 | 4  | 0.00 |
| 1879 | 6 | 5  | 0.06 |
| 1879 | 6 | 6  | 0.36 |
| 1879 | 6 | 7  | 0.40 |
| 1879 | 6 | 8  | 0.10 |
| 1879 | 6 | 9  | 0.00 |
| 1879 | 6 | 10 | 0.00 |
| 1879 | 6 | 11 | 0.00 |
| 1879 | 6 | 12 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1879 | 6 | 13 | 0.00 |
| 1879 | 6 | 14 | 0.06 |
| 1879 | 6 | 15 | 0.00 |
| 1879 | 6 | 16 | 0.00 |
| 1879 | 6 | 17 | 0.00 |
| 1879 | 6 | 18 | 0.00 |
| 1879 | 6 | 19 | 0.00 |
| 1879 | 6 | 20 | 0.00 |
| 1879 | 6 | 21 | 0.04 |
| 1879 | 6 | 22 | 0.28 |
| 1879 | 6 | 23 | 0.20 |
| 1879 | 6 | 24 | 0.20 |
| 1879 | 6 | 25 | 0.06 |
| 1879 | 6 | 26 | 0.00 |
| 1879 | 6 | 27 | 0.00 |
| 1879 | 6 | 28 | 0.00 |
| 1879 | 6 | 29 | 0.00 |
| 1879 | 6 | 30 | 0.00 |
| 1879 | 7 | 1  | 0.00 |
| 1879 | 7 | 2  | 0.03 |
| 1879 | 7 | 3  | 0.00 |
| 1879 | 7 | 4  | 0.00 |
| 1879 | 7 | 5  | 1.30 |
| 1879 | 7 | 6  | 0.17 |
| 1879 | 7 | 7  | 0.00 |
| 1879 | 7 | 8  | 0.00 |
| 1879 | 7 | 9  | 0.02 |
| 1879 | 7 | 10 | 0.00 |
| 1879 | 7 | 11 | 1.30 |
| 1879 | 7 | 12 | 0.00 |
| 1879 | 7 | 13 | 0.90 |
| 1879 | 7 | 14 | 0.00 |
| 1879 | 7 | 15 | 1.00 |
| 1879 | 7 | 16 | 0.00 |
| 1879 | 7 | 17 | 0.00 |
| 1879 | 7 | 18 | 0.00 |
| 1879 | 7 | 19 | 0.00 |
| 1879 | 7 | 20 | 0.00 |
| 1879 | 7 | 21 | 0.00 |
| 1879 | 7 | 22 | 0.00 |
| 1879 | 7 | 23 | 0.00 |
| 1879 | 7 | 24 | 0.00 |
| 1879 | 7 | 25 | 0.00 |



|      |   |    |      |
|------|---|----|------|
| 1879 | 7 | 26 | 0.00 |
| 1879 | 7 | 27 | 0.06 |
| 1879 | 7 | 28 | 0.00 |
| 1879 | 7 | 29 | 0.00 |
| 1879 | 7 | 30 | 0.00 |
| 1879 | 7 | 31 | 0.00 |
| 1879 | 8 | 1  | 0.00 |
| 1879 | 8 | 2  | 0.00 |
| 1879 | 8 | 3  | 0.00 |
| 1879 | 8 | 4  | 0.00 |
| 1879 | 8 | 5  | 0.00 |
| 1879 | 8 | 6  | 0.00 |
| 1879 | 8 | 7  | 0.00 |
| 1879 | 8 | 8  | 0.00 |
| 1879 | 8 | 9  | 0.00 |
| 1879 | 8 | 10 | 0.00 |
| 1879 | 8 | 11 | 0.00 |
| 1879 | 8 | 12 | 0.04 |
| 1879 | 8 | 13 | 0.00 |
| 1879 | 8 | 14 | 0.00 |
| 1879 | 8 | 15 | 0.00 |
| 1879 | 8 | 16 | 0.00 |
| 1879 | 8 | 17 | 0.00 |
| 1879 | 8 | 18 | 0.00 |
| 1879 | 8 | 19 | 0.04 |
| 1879 | 8 | 20 | 0.00 |
| 1879 | 8 | 21 | 1.20 |
| 1879 | 8 | 22 | 0.12 |
| 1879 | 8 | 23 | 0.16 |
| 1879 | 8 | 24 | 0.16 |
| 1879 | 8 | 25 | 0.04 |
| 1879 | 8 | 26 | 0.14 |
| 1879 | 8 | 27 | 0.00 |
| 1879 | 8 | 28 | 0.00 |
| 1879 | 8 | 29 | 0.08 |
| 1879 | 8 | 30 | 0.00 |
| 1879 | 8 | 31 | 0.00 |
| 1879 | 9 | 1  | 0.00 |
| 1879 | 9 | 2  | 0.00 |
| 1879 | 9 | 3  | 0.00 |
| 1879 | 9 | 4  | 0.00 |
| 1879 | 9 | 5  | 0.00 |
| 1879 | 9 | 6  | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1879 | 9  | 7  | 0.00 |
| 1879 | 9  | 8  | 0.68 |
| 1879 | 9  | 9  | 0.40 |
| 1879 | 9  | 10 | 0.00 |
| 1879 | 9  | 11 | 0.00 |
| 1879 | 9  | 12 | 0.00 |
| 1879 | 9  | 13 | 0.00 |
| 1879 | 9  | 14 | 0.04 |
| 1879 | 9  | 15 | 0.00 |
| 1879 | 9  | 16 | 0.00 |
| 1879 | 9  | 17 | 0.00 |
| 1879 | 9  | 18 | 0.00 |
| 1879 | 9  | 19 | 0.00 |
| 1879 | 9  | 20 | 0.00 |
| 1879 | 9  | 21 | 0.00 |
| 1879 | 9  | 22 | 0.00 |
| 1879 | 9  | 23 | 0.00 |
| 1879 | 9  | 24 | 0.00 |
| 1879 | 9  | 25 | 0.00 |
| 1879 | 9  | 26 | 0.00 |
| 1879 | 9  | 27 | 0.46 |
| 1879 | 9  | 28 | 0.30 |
| 1879 | 9  | 29 | 0.20 |
| 1879 | 9  | 30 | 0.90 |
| 1879 | 10 | 1  | 0.00 |
| 1879 | 10 | 2  | 0.23 |
| 1879 | 10 | 3  | 0.00 |
| 1879 | 10 | 4  | 1.12 |
| 1879 | 10 | 5  | 1.52 |
| 1879 | 10 | 6  | 0.44 |
| 1879 | 10 | 7  | 0.00 |
| 1879 | 10 | 8  | 0.00 |
| 1879 | 10 | 9  | 0.32 |
| 1879 | 10 | 10 | 0.20 |
| 1879 | 10 | 11 | 0.30 |
| 1879 | 10 | 12 | 0.60 |
| 1879 | 10 | 13 | 0.00 |
| 1879 | 10 | 14 | 0.30 |
| 1879 | 10 | 15 | 0.40 |
| 1879 | 10 | 16 | 0.04 |
| 1879 | 10 | 17 | 0.50 |
| 1879 | 10 | 18 | 0.00 |
| 1879 | 10 | 19 | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1879 | 10 | 20 | 0.12 |
| 1879 | 10 | 21 | 0.00 |
| 1879 | 10 | 22 | 0.00 |
| 1879 | 10 | 23 | 0.00 |
| 1879 | 10 | 24 | 1.10 |
| 1879 | 10 | 25 | 0.28 |
| 1879 | 10 | 26 | 0.00 |
| 1879 | 10 | 27 | 0.00 |
| 1879 | 10 | 28 | 0.00 |
| 1879 | 10 | 29 | 0.00 |
| 1879 | 10 | 30 | 0.00 |
| 1879 | 10 | 31 | 0.00 |
| 1879 | 11 | 1  | 0.00 |
| 1879 | 11 | 2  | 0.00 |
| 1879 | 11 | 3  | 0.51 |
| 1879 | 11 | 4  | 0.85 |
| 1879 | 11 | 5  | 0.48 |
| 1879 | 11 | 6  | 0.16 |
| 1879 | 11 | 7  | 0.16 |
| 1879 | 11 | 8  | 0.57 |
| 1879 | 11 | 9  | 0.04 |
| 1879 | 11 | 10 | 0.52 |
| 1879 | 11 | 11 | 0.28 |
| 1879 | 11 | 12 | 0.43 |
| 1879 | 11 | 13 | 0.56 |
| 1879 | 11 | 14 | 0.40 |
| 1879 | 11 | 15 | 0.14 |
| 1879 | 11 | 16 | 0.00 |
| 1879 | 11 | 17 | 0.00 |
| 1879 | 11 | 18 | 0.00 |
| 1879 | 11 | 19 | 0.00 |
| 1879 | 11 | 20 | 0.00 |
| 1879 | 11 | 21 | 0.00 |
| 1879 | 11 | 22 | 0.00 |
| 1879 | 11 | 23 | 0.00 |
| 1879 | 11 | 24 | 0.00 |
| 1879 | 11 | 25 | 0.00 |
| 1879 | 11 | 26 | 0.00 |
| 1879 | 11 | 27 | 0.00 |
| 1879 | 11 | 28 | 0.00 |
| 1879 | 11 | 29 | 0.50 |
| 1879 | 11 | 30 | 0.00 |
| 1879 | 12 | 1  | 0.50 |

|      |    |    |      |
|------|----|----|------|
| 1879 | 12 | 2  | 0.20 |
| 1879 | 12 | 3  | 0.36 |
| 1879 | 12 | 4  | 0.92 |
| 1879 | 12 | 5  | 0.46 |
| 1879 | 12 | 6  | 0.25 |
| 1879 | 12 | 7  | 0.36 |
| 1879 | 12 | 8  | 0.00 |
| 1879 | 12 | 9  | 0.14 |
| 1879 | 12 | 10 | 0.00 |
| 1879 | 12 | 11 | 0.40 |
| 1879 | 12 | 12 | 0.12 |
| 1879 | 12 | 13 | 0.92 |
| 1879 | 12 | 14 | 0.12 |
| 1879 | 12 | 15 | 0.20 |
| 1879 | 12 | 16 | 0.17 |
| 1879 | 12 | 17 | 0.20 |
| 1879 | 12 | 18 | 0.22 |
| 1879 | 12 | 19 | 0.70 |
| 1879 | 12 | 20 | 0.00 |
| 1879 | 12 | 21 | 0.10 |
| 1879 | 12 | 22 | 0.00 |
| 1879 | 12 | 23 | 0.00 |
| 1879 | 12 | 24 | 0.00 |
| 1879 | 12 | 25 | 0.08 |
| 1879 | 12 | 26 | 0.78 |
| 1879 | 12 | 27 | 0.34 |
| 1879 | 12 | 28 | 0.48 |
| 1879 | 12 | 29 | 0.00 |
| 1879 | 12 | 30 | 0.44 |
| 1879 | 12 | 31 | 2.14 |
| 1880 | 1  | 1  | 1.28 |
| 1880 | 1  | 2  | 0.60 |
| 1880 | 1  | 3  | 0.18 |
| 1880 | 1  | 4  | 0.14 |
| 1880 | 1  | 5  | 0.70 |
| 1880 | 1  | 6  | 1.30 |
| 1880 | 1  | 7  | 2.70 |
| 1880 | 1  | 8  | 0.16 |
| 1880 | 1  | 9  | 0.50 |
| 1880 | 1  | 10 | 0.70 |
| 1880 | 1  | 11 | 0.20 |
| 1880 | 1  | 12 | 1.50 |
| 1880 | 1  | 13 | 1.46 |

|      |   |    |      |
|------|---|----|------|
| 1880 | 1 | 14 | 0.24 |
| 1880 | 1 | 15 | 2.50 |
| 1880 | 1 | 16 | 0.52 |
| 1880 | 1 | 17 | 2.84 |
| 1880 | 1 | 18 | 0.48 |
| 1880 | 1 | 19 | 0.14 |
| 1880 | 1 | 20 | 0.92 |
| 1880 | 1 | 21 | 0.18 |
| 1880 | 1 | 22 | 0.54 |
| 1880 | 1 | 23 | 0.16 |
| 1880 | 1 | 24 | 1.34 |
| 1880 | 1 | 25 | 0.04 |
| 1880 | 1 | 26 | 0.12 |
| 1880 | 1 | 27 | 0.30 |
| 1880 | 1 | 28 | 0.10 |
| 1880 | 1 | 29 | 0.08 |
| 1880 | 1 | 30 | 0.00 |
| 1880 | 1 | 31 | 0.00 |
| 1880 | 2 | 1  | 0.00 |
| 1880 | 2 | 2  | 0.00 |
| 1880 | 2 | 3  | 0.00 |
| 1880 | 2 | 4  | 0.00 |
| 1880 | 2 | 5  | 0.00 |
| 1880 | 2 | 6  | 0.00 |
| 1880 | 2 | 7  | 0.08 |
| 1880 | 2 | 8  | 0.00 |
| 1880 | 2 | 9  | 0.00 |
| 1880 | 2 | 10 | 0.36 |
| 1880 | 2 | 11 | 0.12 |
| 1880 | 2 | 12 | 0.54 |
| 1880 | 2 | 13 | 0.40 |
| 1880 | 2 | 14 | 1.26 |
| 1880 | 2 | 15 | 0.48 |
| 1880 | 2 | 16 | 0.44 |
| 1880 | 2 | 17 | 0.16 |
| 1880 | 2 | 18 | 0.90 |
| 1880 | 2 | 19 | 0.90 |
| 1880 | 2 | 20 | 0.00 |
| 1880 | 2 | 21 | 0.00 |
| 1880 | 2 | 22 | 0.00 |
| 1880 | 2 | 23 | 0.06 |
| 1880 | 2 | 24 | 0.00 |
| 1880 | 2 | 25 | 0.34 |

|      |   |    |      |
|------|---|----|------|
| 1880 | 2 | 26 | 0.00 |
| 1880 | 2 | 27 | 0.00 |
| 1880 | 2 | 28 | 0.00 |
| 1880 | 2 | 29 | 1.32 |
| 1880 | 3 | 1  | 0.94 |
| 1880 | 3 | 2  | 0.14 |
| 1880 | 3 | 3  | 0.54 |
| 1880 | 3 | 4  | 0.16 |
| 1880 | 3 | 5  | 0.34 |
| 1880 | 3 | 6  | 0.30 |
| 1880 | 3 | 7  | 0.10 |
| 1880 | 3 | 8  | 0.10 |
| 1880 | 3 | 9  | 0.00 |
| 1880 | 3 | 10 | 0.04 |
| 1880 | 3 | 11 | 0.00 |
| 1880 | 3 | 12 | 0.00 |
| 1880 | 3 | 13 | 0.00 |
| 1880 | 3 | 14 | 0.00 |
| 1880 | 3 | 15 | 0.00 |
| 1880 | 3 | 16 | 0.20 |
| 1880 | 3 | 17 | 0.00 |
| 1880 | 3 | 18 | 0.06 |
| 1880 | 3 | 19 | 0.14 |
| 1880 | 3 | 20 | 0.04 |
| 1880 | 3 | 21 | 0.00 |
| 1880 | 3 | 22 | 0.00 |
| 1880 | 3 | 23 | 0.00 |
| 1880 | 3 | 24 | 0.00 |
| 1880 | 3 | 25 | 0.26 |
| 1880 | 3 | 26 | 0.52 |
| 1880 | 3 | 27 | 1.60 |
| 1880 | 3 | 28 | 0.48 |
| 1880 | 3 | 29 | 0.28 |
| 1880 | 3 | 30 | 0.18 |
| 1880 | 3 | 31 | 0.26 |
| 1880 | 4 | 1  | 0.00 |
| 1880 | 4 | 2  | 0.00 |
| 1880 | 4 | 3  | 0.00 |
| 1880 | 4 | 4  | 0.20 |
| 1880 | 4 | 5  | 0.00 |
| 1880 | 4 | 6  | 0.00 |
| 1880 | 4 | 7  | 0.00 |
| 1880 | 4 | 8  | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1880 | 4 | 9  | 0.00 |
| 1880 | 4 | 10 | 0.28 |
| 1880 | 4 | 11 | 0.15 |
| 1880 | 4 | 12 | 0.40 |
| 1880 | 4 | 13 | 0.06 |
| 1880 | 4 | 14 | 0.00 |
| 1880 | 4 | 15 | 0.52 |
| 1880 | 4 | 16 | 0.42 |
| 1880 | 4 | 17 | 0.36 |
| 1880 | 4 | 18 | 0.08 |
| 1880 | 4 | 19 | 0.32 |
| 1880 | 4 | 20 | 0.20 |
| 1880 | 4 | 21 | 0.30 |
| 1880 | 4 | 22 | 0.08 |
| 1880 | 4 | 23 | 0.00 |
| 1880 | 4 | 24 | 0.00 |
| 1880 | 4 | 25 | 0.00 |
| 1880 | 4 | 26 | 0.00 |
| 1880 | 4 | 27 | 0.00 |
| 1880 | 4 | 28 | 0.00 |
| 1880 | 4 | 29 | 0.00 |
| 1880 | 4 | 30 | 0.00 |
| 1880 | 5 | 1  | 0.00 |
| 1880 | 5 | 2  | 0.24 |
| 1880 | 5 | 3  | 0.24 |
| 1880 | 5 | 4  | 0.34 |
| 1880 | 5 | 5  | 0.64 |
| 1880 | 5 | 6  | 0.34 |
| 1880 | 5 | 7  | 1.10 |
| 1880 | 5 | 8  | 0.14 |
| 1880 | 5 | 9  | 0.14 |
| 1880 | 5 | 10 | 0.08 |
| 1880 | 5 | 11 | 0.26 |
| 1880 | 5 | 12 | 0.11 |
| 1880 | 5 | 13 | 0.00 |
| 1880 | 5 | 14 | 0.00 |
| 1880 | 5 | 15 | 0.00 |
| 1880 | 5 | 16 | 0.00 |
| 1880 | 5 | 17 | 0.00 |
| 1880 | 5 | 18 | 0.00 |
| 1880 | 5 | 19 | 0.08 |
| 1880 | 5 | 20 | 0.29 |
| 1880 | 5 | 21 | 0.08 |

|      |   |    |      |
|------|---|----|------|
| 1880 | 5 | 22 | 0.26 |
| 1880 | 5 | 23 | 0.30 |
| 1880 | 5 | 24 | 0.10 |
| 1880 | 5 | 25 | 0.00 |
| 1880 | 5 | 26 | 0.00 |
| 1880 | 5 | 27 | 0.00 |
| 1880 | 5 | 28 | 0.00 |
| 1880 | 5 | 29 | 0.00 |
| 1880 | 5 | 30 | 0.00 |
| 1880 | 5 | 31 | 0.00 |
| 1880 | 6 | 1  | 0.02 |
| 1880 | 6 | 2  | 0.06 |
| 1880 | 6 | 3  | 0.02 |
| 1880 | 6 | 4  | 0.10 |
| 1880 | 6 | 5  | 0.24 |
| 1880 | 6 | 6  | 0.02 |
| 1880 | 6 | 7  | 0.12 |
| 1880 | 6 | 8  | 0.62 |
| 1880 | 6 | 9  | 0.66 |
| 1880 | 6 | 10 | 0.00 |
| 1880 | 6 | 11 | 0.00 |
| 1880 | 6 | 12 | 0.04 |
| 1880 | 6 | 13 | 0.00 |
| 1880 | 6 | 14 | 0.00 |
| 1880 | 6 | 15 | 0.00 |
| 1880 | 6 | 16 | 0.00 |
| 1880 | 6 | 17 | 0.10 |
| 1880 | 6 | 18 | 0.06 |
| 1880 | 6 | 19 | 0.04 |
| 1880 | 6 | 20 | 0.20 |
| 1880 | 6 | 21 | 0.06 |
| 1880 | 6 | 22 | 0.00 |
| 1880 | 6 | 23 | 0.00 |
| 1880 | 6 | 24 | 0.00 |
| 1880 | 6 | 25 | 0.00 |
| 1880 | 6 | 26 | 0.00 |
| 1880 | 6 | 27 | 0.00 |
| 1880 | 6 | 28 | 0.02 |
| 1880 | 6 | 29 | 0.04 |
| 1880 | 6 | 30 | 0.00 |
| 1880 | 7 | 1  | 0.00 |
| 1880 | 7 | 2  | 0.00 |
| 1880 | 7 | 3  | 0.00 |



|      |   |    |      |
|------|---|----|------|
| 1880 | 7 | 4  | 0.00 |
| 1880 | 7 | 5  | 0.00 |
| 1880 | 7 | 6  | 0.10 |
| 1880 | 7 | 7  | 0.20 |
| 1880 | 7 | 8  | 0.02 |
| 1880 | 7 | 9  | 0.30 |
| 1880 | 7 | 10 | 0.16 |
| 1880 | 7 | 11 | 0.02 |
| 1880 | 7 | 12 | 0.36 |
| 1880 | 7 | 13 | 0.00 |
| 1880 | 7 | 14 | 0.00 |
| 1880 | 7 | 15 | 0.00 |
| 1880 | 7 | 16 | 0.00 |
| 1880 | 7 | 17 | 0.00 |
| 1880 | 7 | 18 | 0.04 |
| 1880 | 7 | 19 | 0.00 |
| 1880 | 7 | 20 | 0.00 |
| 1880 | 7 | 21 | 0.00 |
| 1880 | 7 | 22 | 0.00 |
| 1880 | 7 | 23 | 0.00 |
| 1880 | 7 | 24 | 0.00 |
| 1880 | 7 | 25 | 0.00 |
| 1880 | 7 | 26 | 0.00 |
| 1880 | 7 | 27 | 0.00 |
| 1880 | 7 | 28 | 0.00 |
| 1880 | 7 | 29 | 0.16 |
| 1880 | 7 | 30 | 0.04 |
| 1880 | 7 | 31 | 0.08 |
| 1880 | 8 | 1  | 0.00 |
| 1880 | 8 | 2  | 0.00 |
| 1880 | 8 | 3  | 0.00 |
| 1880 | 8 | 4  | 0.00 |
| 1880 | 8 | 5  | 0.00 |
| 1880 | 8 | 6  | 0.00 |
| 1880 | 8 | 7  | 0.00 |
| 1880 | 8 | 8  | 0.00 |
| 1880 | 8 | 9  | 0.00 |
| 1880 | 8 | 10 | 0.02 |
| 1880 | 8 | 11 | 0.00 |
| 1880 | 8 | 12 | 0.00 |
| 1880 | 8 | 13 | 0.00 |
| 1880 | 8 | 14 | 0.02 |
| 1880 | 8 | 15 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1880 | 8 | 16 | 0.00 |
| 1880 | 8 | 17 | 0.00 |
| 1880 | 8 | 18 | 0.00 |
| 1880 | 8 | 19 | 0.00 |
| 1880 | 8 | 20 | 0.00 |
| 1880 | 8 | 21 | 0.00 |
| 1880 | 8 | 22 | 0.00 |
| 1880 | 8 | 23 | 0.02 |
| 1880 | 8 | 24 | 0.00 |
| 1880 | 8 | 25 | 0.00 |
| 1880 | 8 | 26 | 0.00 |
| 1880 | 8 | 27 | 0.04 |
| 1880 | 8 | 28 | 0.40 |
| 1880 | 8 | 29 | 0.20 |
| 1880 | 8 | 30 | 0.00 |
| 1880 | 8 | 31 | 0.08 |
| 1880 | 9 | 1  | 0.00 |
| 1880 | 9 | 2  | 0.08 |
| 1880 | 9 | 3  | 0.00 |
| 1880 | 9 | 4  | 0.00 |
| 1880 | 9 | 5  | 0.00 |
| 1880 | 9 | 6  | 0.00 |
| 1880 | 9 | 7  | 0.00 |
| 1880 | 9 | 8  | 0.00 |
| 1880 | 9 | 9  | 0.16 |
| 1880 | 9 | 10 | 0.02 |
| 1880 | 9 | 11 | 0.00 |
| 1880 | 9 | 12 | 0.00 |
| 1880 | 9 | 13 | 0.00 |
| 1880 | 9 | 14 | 0.00 |
| 1880 | 9 | 15 | 0.44 |
| 1880 | 9 | 16 | 0.00 |
| 1880 | 9 | 17 | 0.00 |
| 1880 | 9 | 18 | 0.00 |
| 1880 | 9 | 19 | 0.00 |
| 1880 | 9 | 20 | 0.00 |
| 1880 | 9 | 21 | 0.22 |
| 1880 | 9 | 22 | 0.28 |
| 1880 | 9 | 23 | 0.60 |
| 1880 | 9 | 24 | 0.00 |
| 1880 | 9 | 25 | 0.00 |
| 1880 | 9 | 26 | 0.00 |
| 1880 | 9 | 27 | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1880 | 9  | 28 | 0.00 |
| 1880 | 9  | 29 | 0.00 |
| 1880 | 9  | 30 | 0.00 |
| 1880 | 10 | 1  | 0.00 |
| 1880 | 10 | 2  | 0.00 |
| 1880 | 10 | 3  | 0.00 |
| 1880 | 10 | 4  | 0.00 |
| 1880 | 10 | 5  | 0.00 |
| 1880 | 10 | 6  | 0.00 |
| 1880 | 10 | 7  | 0.03 |
| 1880 | 10 | 8  | 0.00 |
| 1880 | 10 | 9  | 0.42 |
| 1880 | 10 | 10 | 0.00 |
| 1880 | 10 | 11 | 0.00 |
| 1880 | 10 | 12 | 0.00 |
| 1880 | 10 | 13 | 0.00 |
| 1880 | 10 | 14 | 0.05 |
| 1880 | 10 | 15 | 0.00 |
| 1880 | 10 | 16 | 0.00 |
| 1880 | 10 | 17 | 0.00 |
| 1880 | 10 | 18 | 0.00 |
| 1880 | 10 | 19 | 0.00 |
| 1880 | 10 | 20 | 0.00 |
| 1880 | 10 | 21 | 0.00 |
| 1880 | 10 | 22 | 0.00 |
| 1880 | 10 | 23 | 0.00 |
| 1880 | 10 | 24 | 0.72 |
| 1880 | 10 | 25 | 0.88 |
| 1880 | 10 | 26 | 0.20 |
| 1880 | 10 | 27 | 0.96 |
| 1880 | 10 | 28 | 0.04 |
| 1880 | 10 | 29 | 0.07 |
| 1880 | 10 | 30 | 0.00 |
| 1880 | 10 | 31 | 0.40 |
| 1880 | 11 | 1  | 0.00 |
| 1880 | 11 | 2  | 0.62 |
| 1880 | 11 | 3  | 0.22 |
| 1880 | 11 | 4  | 0.00 |
| 1880 | 11 | 5  | 0.00 |
| 1880 | 11 | 6  | 0.00 |
| 1880 | 11 | 7  | 0.54 |
| 1880 | 11 | 8  | 0.02 |
| 1880 | 11 | 9  | 0.40 |

|      |    |    |      |
|------|----|----|------|
| 1880 | 11 | 10 | 0.19 |
| 1880 | 11 | 11 | 0.00 |
| 1880 | 11 | 12 | 0.00 |
| 1880 | 11 | 13 | 0.00 |
| 1880 | 11 | 14 | 0.00 |
| 1880 | 11 | 15 | 0.00 |
| 1880 | 11 | 16 | 0.00 |
| 1880 | 11 | 17 | 0.00 |
| 1880 | 11 | 18 | 0.00 |
| 1880 | 11 | 19 | 0.00 |
| 1880 | 11 | 20 | 0.34 |
| 1880 | 11 | 21 | 0.00 |
| 1880 | 11 | 22 | 0.00 |
| 1880 | 11 | 23 | 0.00 |
| 1880 | 11 | 24 | 0.00 |
| 1880 | 11 | 25 | 0.00 |
| 1880 | 11 | 26 | 0.00 |
| 1880 | 11 | 27 | 0.00 |
| 1880 | 11 | 28 | 0.00 |
| 1880 | 11 | 29 | 0.00 |
| 1880 | 11 | 30 | 0.50 |
| 1880 | 12 | 1  | 0.00 |
| 1880 | 12 | 2  | 0.26 |
| 1880 | 12 | 3  | 0.16 |
| 1880 | 12 | 4  | 0.00 |
| 1880 | 12 | 5  | 0.00 |
| 1880 | 12 | 6  | 0.00 |
| 1880 | 12 | 7  | 3.20 |
| 1880 | 12 | 8  | 0.00 |
| 1880 | 12 | 9  | 0.00 |
| 1880 | 12 | 10 | 0.00 |
| 1880 | 12 | 11 | 0.00 |
| 1880 | 12 | 12 | 2.52 |
| 1880 | 12 | 13 | 0.00 |
| 1880 | 12 | 14 | 0.00 |
| 1880 | 12 | 15 | 1.90 |
| 1880 | 12 | 16 | 0.22 |
| 1880 | 12 | 17 | 0.00 |
| 1880 | 12 | 18 | 0.00 |
| 1880 | 12 | 19 | 0.28 |
| 1880 | 12 | 20 | 0.00 |
| 1880 | 12 | 21 | 0.00 |
| 1880 | 12 | 22 | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1880 | 12 | 23 | 0.00 |
| 1880 | 12 | 24 | 0.00 |
| 1880 | 12 | 25 | 0.48 |
| 1880 | 12 | 26 | 0.70 |
| 1880 | 12 | 27 | 0.60 |
| 1880 | 12 | 28 | 0.70 |
| 1880 | 12 | 29 | 0.76 |
| 1880 | 12 | 30 | 0.20 |
| 1880 | 12 | 31 | 1.56 |
| 1881 | 1  | 1  | 0.00 |
| 1881 | 1  | 2  | 0.00 |
| 1881 | 1  | 3  | 0.24 |
| 1881 | 1  | 4  | 0.38 |
| 1881 | 1  | 5  | 0.08 |
| 1881 | 1  | 6  | 0.10 |
| 1881 | 1  | 7  | 0.10 |
| 1881 | 1  | 8  | 0.00 |
| 1881 | 1  | 9  | 0.16 |
| 1881 | 1  | 10 | 0.18 |
| 1881 | 1  | 11 | 2.30 |
| 1881 | 1  | 12 | 1.28 |
| 1881 | 1  | 13 | 0.16 |
| 1881 | 1  | 14 | 0.20 |
| 1881 | 1  | 15 | 0.00 |
| 1881 | 1  | 16 | 0.00 |
| 1881 | 1  | 17 | 0.60 |
| 1881 | 1  | 18 | 2.08 |
| 1881 | 1  | 19 | 0.00 |
| 1881 | 1  | 20 | 0.00 |
| 1881 | 1  | 21 | 0.00 |
| 1881 | 1  | 22 | 0.00 |
| 1881 | 1  | 23 | 0.00 |
| 1881 | 1  | 24 | 0.30 |
| 1881 | 1  | 25 | 0.00 |
| 1881 | 1  | 26 | 0.00 |
| 1881 | 1  | 27 | 0.40 |
| 1881 | 1  | 28 | 0.40 |
| 1881 | 1  | 29 | 0.00 |
| 1881 | 1  | 30 | 0.00 |
| 1881 | 1  | 31 | 0.88 |
| 1881 | 2  | 1  | 1.30 |
| 1881 | 2  | 2  | 0.98 |
| 1881 | 2  | 3  | 1.08 |

|      |   |    |      |
|------|---|----|------|
| 1881 | 2 | 4  | 0.94 |
| 1881 | 2 | 5  | 0.54 |
| 1881 | 2 | 6  | 0.40 |
| 1881 | 2 | 7  | 0.54 |
| 1881 | 2 | 8  | 0.20 |
| 1881 | 2 | 9  | 0.08 |
| 1881 | 2 | 10 | 0.06 |
| 1881 | 2 | 11 | 0.84 |
| 1881 | 2 | 12 | 0.36 |
| 1881 | 2 | 13 | 0.40 |
| 1881 | 2 | 14 | 0.00 |
| 1881 | 2 | 15 | 0.00 |
| 1881 | 2 | 16 | 0.00 |
| 1881 | 2 | 17 | 0.00 |
| 1881 | 2 | 18 | 0.20 |
| 1881 | 2 | 19 | 0.08 |
| 1881 | 2 | 20 | 0.58 |
| 1881 | 2 | 21 | 0.42 |
| 1881 | 2 | 22 | 0.16 |
| 1881 | 2 | 23 | 0.70 |
| 1881 | 2 | 24 | 0.20 |
| 1881 | 2 | 25 | 0.92 |
| 1881 | 2 | 26 | 0.22 |
| 1881 | 2 | 27 | 0.90 |
| 1881 | 2 | 28 | 1.28 |
| 1881 | 3 | 1  | 0.22 |
| 1881 | 3 | 2  | 0.08 |
| 1881 | 3 | 3  | 0.00 |
| 1881 | 3 | 4  | 0.40 |
| 1881 | 3 | 5  | 0.28 |
| 1881 | 3 | 6  | 0.16 |
| 1881 | 3 | 7  | 0.20 |
| 1881 | 3 | 8  | 0.08 |
| 1881 | 3 | 9  | 0.88 |
| 1881 | 3 | 10 | 0.54 |
| 1881 | 3 | 11 | 0.72 |
| 1881 | 3 | 12 | 0.38 |
| 1881 | 3 | 13 | 0.16 |
| 1881 | 3 | 14 | 0.00 |
| 1881 | 3 | 15 | 0.14 |
| 1881 | 3 | 16 | 0.30 |
| 1881 | 3 | 17 | 0.00 |
| 1881 | 3 | 18 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1881 | 3 | 19 | 0.24 |
| 1881 | 3 | 20 | 0.04 |
| 1881 | 3 | 21 | 0.00 |
| 1881 | 3 | 22 | 0.00 |
| 1881 | 3 | 23 | 0.04 |
| 1881 | 3 | 24 | 0.08 |
| 1881 | 3 | 25 | 0.34 |
| 1881 | 3 | 26 | 0.76 |
| 1881 | 3 | 27 | 1.38 |
| 1881 | 3 | 28 | 0.00 |
| 1881 | 3 | 29 | 0.16 |
| 1881 | 3 | 30 | 0.00 |
| 1881 | 3 | 31 | 0.00 |
| 1881 | 4 | 1  | 0.00 |
| 1881 | 4 | 2  | 0.00 |
| 1881 | 4 | 3  | 0.00 |
| 1881 | 4 | 4  | 0.00 |
| 1881 | 4 | 5  | 0.00 |
| 1881 | 4 | 6  | 0.50 |
| 1881 | 4 | 7  | 0.00 |
| 1881 | 4 | 8  | 0.45 |
| 1881 | 4 | 9  | 0.00 |
| 1881 | 4 | 10 | 0.00 |
| 1881 | 4 | 11 | 0.25 |
| 1881 | 4 | 12 | 0.00 |
| 1881 | 4 | 13 | 0.00 |
| 1881 | 4 | 14 | 0.31 |
| 1881 | 4 | 15 | 0.18 |
| 1881 | 4 | 16 | 0.30 |
| 1881 | 4 | 17 | 0.25 |
| 1881 | 4 | 18 | 0.00 |
| 1881 | 4 | 19 | 0.40 |
| 1881 | 4 | 20 | 0.60 |
| 1881 | 4 | 21 | 0.31 |
| 1881 | 4 | 22 | 0.12 |
| 1881 | 4 | 23 | 0.60 |
| 1881 | 4 | 24 | 0.00 |
| 1881 | 4 | 25 | 0.57 |
| 1881 | 4 | 26 | 0.67 |
| 1881 | 4 | 27 | 0.00 |
| 1881 | 4 | 28 | 0.00 |
| 1881 | 4 | 29 | 0.00 |
| 1881 | 4 | 30 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1881 | 5 | 1  | 0.00 |
| 1881 | 5 | 2  | 0.00 |
| 1881 | 5 | 3  | 0.00 |
| 1881 | 5 | 4  | 0.00 |
| 1881 | 5 | 5  | 1.22 |
| 1881 | 5 | 6  | 0.08 |
| 1881 | 5 | 7  | 0.00 |
| 1881 | 5 | 8  | 0.00 |
| 1881 | 5 | 9  | 0.00 |
| 1881 | 5 | 10 | 0.02 |
| 1881 | 5 | 11 | 0.00 |
| 1881 | 5 | 12 | 0.00 |
| 1881 | 5 | 13 | 0.03 |
| 1881 | 5 | 14 | 0.00 |
| 1881 | 5 | 15 | 0.08 |
| 1881 | 5 | 16 | 0.00 |
| 1881 | 5 | 17 | 0.00 |
| 1881 | 5 | 18 | 0.00 |
| 1881 | 5 | 19 | 0.00 |
| 1881 | 5 | 20 | 0.00 |
| 1881 | 5 | 21 | 0.00 |
| 1881 | 5 | 22 | 0.00 |
| 1881 | 5 | 23 | 0.00 |
| 1881 | 5 | 24 | 0.03 |
| 1881 | 5 | 25 | 0.52 |
| 1881 | 5 | 26 | 0.08 |
| 1881 | 5 | 27 | 0.02 |
| 1881 | 5 | 28 | 0.30 |
| 1881 | 5 | 29 | 0.03 |
| 1881 | 5 | 30 | 0.00 |
| 1881 | 5 | 31 | 0.44 |
| 1881 | 6 | 1  | 0.00 |
| 1881 | 6 | 2  | 0.00 |
| 1881 | 6 | 3  | 0.00 |
| 1881 | 6 | 4  | 0.00 |
| 1881 | 6 | 5  | 0.00 |
| 1881 | 6 | 6  | 0.12 |
| 1881 | 6 | 7  | 0.40 |
| 1881 | 6 | 8  | 0.08 |
| 1881 | 6 | 9  | 0.12 |
| 1881 | 6 | 10 | 0.10 |
| 1881 | 6 | 11 | 0.08 |
| 1881 | 6 | 12 | 0.68 |



|      |   |    |      |
|------|---|----|------|
| 1881 | 6 | 13 | 0.24 |
| 1881 | 6 | 14 | 0.00 |
| 1881 | 6 | 15 | 0.06 |
| 1881 | 6 | 16 | 0.00 |
| 1881 | 6 | 17 | 0.04 |
| 1881 | 6 | 18 | 0.00 |
| 1881 | 6 | 19 | 0.00 |
| 1881 | 6 | 20 | 0.00 |
| 1881 | 6 | 21 | 0.36 |
| 1881 | 6 | 22 | 0.00 |
| 1881 | 6 | 23 | 0.00 |
| 1881 | 6 | 24 | 0.00 |
| 1881 | 6 | 25 | 0.30 |
| 1881 | 6 | 26 | 0.00 |
| 1881 | 6 | 27 | 0.00 |
| 1881 | 6 | 28 | 0.54 |
| 1881 | 6 | 29 | 0.00 |
| 1881 | 6 | 30 | 0.00 |
| 1881 | 7 | 1  | 0.00 |
| 1881 | 7 | 2  | 0.00 |
| 1881 | 7 | 3  | 0.00 |
| 1881 | 7 | 4  | 0.00 |
| 1881 | 7 | 5  | 0.00 |
| 1881 | 7 | 6  | 0.00 |
| 1881 | 7 | 7  | 0.14 |
| 1881 | 7 | 8  | 0.16 |
| 1881 | 7 | 9  | 0.00 |
| 1881 | 7 | 10 | 0.05 |
| 1881 | 7 | 11 | 0.16 |
| 1881 | 7 | 12 | 0.00 |
| 1881 | 7 | 13 | 0.00 |
| 1881 | 7 | 14 | 0.00 |
| 1881 | 7 | 15 | 0.00 |
| 1881 | 7 | 16 | 0.00 |
| 1881 | 7 | 17 | 0.08 |
| 1881 | 7 | 18 | 0.00 |
| 1881 | 7 | 19 | 0.00 |
| 1881 | 7 | 20 | 0.08 |
| 1881 | 7 | 21 | 0.00 |
| 1881 | 7 | 22 | 0.00 |
| 1881 | 7 | 23 | 0.00 |
| 1881 | 7 | 24 | 0.00 |
| 1881 | 7 | 25 | 0.03 |

|      |   |    |      |
|------|---|----|------|
| 1881 | 7 | 26 | 0.00 |
| 1881 | 7 | 27 | 0.12 |
| 1881 | 7 | 28 | 0.08 |
| 1881 | 7 | 29 | 0.14 |
| 1881 | 7 | 30 | 0.36 |
| 1881 | 7 | 31 | 0.24 |
| 1881 | 8 | 1  | 0.00 |
| 1881 | 8 | 2  | 0.00 |
| 1881 | 8 | 3  | 0.00 |
| 1881 | 8 | 4  | 0.00 |
| 1881 | 8 | 5  | 0.00 |
| 1881 | 8 | 6  | 0.00 |
| 1881 | 8 | 7  | 0.00 |
| 1881 | 8 | 8  | 0.04 |
| 1881 | 8 | 9  | 0.18 |
| 1881 | 8 | 10 | 0.00 |
| 1881 | 8 | 11 | 0.00 |
| 1881 | 8 | 12 | 0.22 |
| 1881 | 8 | 13 | 0.18 |
| 1881 | 8 | 14 | 0.00 |
| 1881 | 8 | 15 | 0.00 |
| 1881 | 8 | 16 | 0.00 |
| 1881 | 8 | 17 | 0.00 |
| 1881 | 8 | 18 | 0.00 |
| 1881 | 8 | 19 | 0.00 |
| 1881 | 8 | 20 | 0.00 |
| 1881 | 8 | 21 | 0.00 |
| 1881 | 8 | 22 | 0.00 |
| 1881 | 8 | 23 | 0.00 |
| 1881 | 8 | 24 | 0.04 |
| 1881 | 8 | 25 | 0.00 |
| 1881 | 8 | 26 | 0.00 |
| 1881 | 8 | 27 | 0.00 |
| 1881 | 8 | 28 | 0.22 |
| 1881 | 8 | 29 | 0.00 |
| 1881 | 8 | 30 | 0.00 |
| 1881 | 8 | 31 | 0.00 |
| 1881 | 9 | 1  | 0.00 |
| 1881 | 9 | 2  | 0.00 |
| 1881 | 9 | 3  | 0.00 |
| 1881 | 9 | 4  | 0.16 |
| 1881 | 9 | 5  | 0.00 |
| 1881 | 9 | 6  | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1881 | 9  | 7  | 0.12 |
| 1881 | 9  | 8  | 0.00 |
| 1881 | 9  | 9  | 0.00 |
| 1881 | 9  | 10 | 0.00 |
| 1881 | 9  | 11 | 0.00 |
| 1881 | 9  | 12 | 0.00 |
| 1881 | 9  | 13 | 0.00 |
| 1881 | 9  | 14 | 0.00 |
| 1881 | 9  | 15 | 0.00 |
| 1881 | 9  | 16 | 0.04 |
| 1881 | 9  | 17 | 0.00 |
| 1881 | 9  | 18 | 0.00 |
| 1881 | 9  | 19 | 0.00 |
| 1881 | 9  | 20 | 0.12 |
| 1881 | 9  | 21 | 0.00 |
| 1881 | 9  | 22 | 0.00 |
| 1881 | 9  | 23 | 0.14 |
| 1881 | 9  | 24 | 1.04 |
| 1881 | 9  | 25 | 0.56 |
| 1881 | 9  | 26 | 0.00 |
| 1881 | 9  | 27 | 0.00 |
| 1881 | 9  | 28 | 0.14 |
| 1881 | 9  | 29 | 0.14 |
| 1881 | 9  | 30 | 0.04 |
| 1881 | 10 | 1  | 0.30 |
| 1881 | 10 | 2  | 0.00 |
| 1881 | 10 | 3  | 0.03 |
| 1881 | 10 | 4  | 0.00 |
| 1881 | 10 | 5  | 0.00 |
| 1881 | 10 | 6  | 0.00 |
| 1881 | 10 | 7  | 0.00 |
| 1881 | 10 | 8  | 0.00 |
| 1881 | 10 | 9  | 0.00 |
| 1881 | 10 | 10 | 0.00 |
| 1881 | 10 | 11 | 0.02 |
| 1881 | 10 | 12 | 0.00 |
| 1881 | 10 | 13 | 0.00 |
| 1881 | 10 | 14 | 0.03 |
| 1881 | 10 | 15 | 0.46 |
| 1881 | 10 | 16 | 0.12 |
| 1881 | 10 | 17 | 1.60 |
| 1881 | 10 | 18 | 1.30 |
| 1881 | 10 | 19 | 0.87 |

|      |    |    |      |
|------|----|----|------|
| 1881 | 10 | 20 | 0.40 |
| 1881 | 10 | 21 | 0.00 |
| 1881 | 10 | 22 | 0.00 |
| 1881 | 10 | 23 | 0.00 |
| 1881 | 10 | 24 | 0.00 |
| 1881 | 10 | 25 | 0.00 |
| 1881 | 10 | 26 | 0.68 |
| 1881 | 10 | 27 | 0.00 |
| 1881 | 10 | 28 | 0.74 |
| 1881 | 10 | 29 | 0.43 |
| 1881 | 10 | 30 | 0.66 |
| 1881 | 10 | 31 | 0.20 |
| 1881 | 11 | 1  | 0.00 |
| 1881 | 11 | 2  | 0.00 |
| 1881 | 11 | 3  | 0.30 |
| 1881 | 11 | 4  | 0.24 |
| 1881 | 11 | 5  | 1.02 |
| 1881 | 11 | 6  | 0.34 |
| 1881 | 11 | 7  | 0.06 |
| 1881 | 11 | 8  | 0.50 |
| 1881 | 11 | 9  | 0.00 |
| 1881 | 11 | 10 | 0.00 |
| 1881 | 11 | 11 | 0.04 |
| 1881 | 11 | 12 | 0.14 |
| 1881 | 11 | 13 | 0.11 |
| 1881 | 11 | 14 | 0.22 |
| 1881 | 11 | 15 | 0.39 |
| 1881 | 11 | 16 | 0.56 |
| 1881 | 11 | 17 | 0.00 |
| 1881 | 11 | 18 | 0.00 |
| 1881 | 11 | 19 | 0.08 |
| 1881 | 11 | 20 | 0.32 |
| 1881 | 11 | 21 | 0.00 |
| 1881 | 11 | 22 | 0.00 |
| 1881 | 11 | 23 | 0.00 |
| 1881 | 11 | 24 | 0.00 |
| 1881 | 11 | 25 | 0.00 |
| 1881 | 11 | 26 | 0.00 |
| 1881 | 11 | 27 | 0.00 |
| 1881 | 11 | 28 | 0.80 |
| 1881 | 11 | 29 | 0.00 |
| 1881 | 11 | 30 | 0.00 |
| 1881 | 12 | 1  | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1881 | 12 | 2  | 0.00 |
| 1881 | 12 | 3  | 0.00 |
| 1881 | 12 | 4  | 0.05 |
| 1881 | 12 | 5  | 0.56 |
| 1881 | 12 | 6  | 0.00 |
| 1881 | 12 | 7  | 0.00 |
| 1881 | 12 | 8  | 0.02 |
| 1881 | 12 | 9  | 0.00 |
| 1881 | 12 | 10 | 0.00 |
| 1881 | 12 | 11 | 0.42 |
| 1881 | 12 | 12 | 0.00 |
| 1881 | 12 | 13 | 0.26 |
| 1881 | 12 | 14 | 0.56 |
| 1881 | 12 | 15 | 1.12 |
| 1881 | 12 | 16 | 0.44 |
| 1881 | 12 | 17 | 0.28 |
| 1881 | 12 | 18 | 0.56 |
| 1881 | 12 | 19 | 0.00 |
| 1881 | 12 | 20 | 0.00 |
| 1881 | 12 | 21 | 0.54 |
| 1881 | 12 | 22 | 0.08 |
| 1881 | 12 | 23 | 0.00 |
| 1881 | 12 | 24 | 1.72 |
| 1881 | 12 | 25 | 0.00 |
| 1881 | 12 | 26 | 0.69 |
| 1881 | 12 | 27 | 0.03 |
| 1881 | 12 | 28 | 0.07 |
| 1881 | 12 | 29 | 0.08 |
| 1881 | 12 | 30 | 0.00 |
| 1881 | 12 | 31 | 1.42 |
| 1882 | 1  | 1  | 0.60 |
| 1882 | 1  | 2  | 0.00 |
| 1882 | 1  | 3  | 0.16 |
| 1882 | 1  | 4  | 0.60 |
| 1882 | 1  | 5  | 0.28 |
| 1882 | 1  | 6  | 0.60 |
| 1882 | 1  | 7  | 0.00 |
| 1882 | 1  | 8  | 0.16 |
| 1882 | 1  | 9  | 0.36 |
| 1882 | 1  | 10 | 0.60 |
| 1882 | 1  | 11 | 0.10 |
| 1882 | 1  | 12 | 0.00 |
| 1882 | 1  | 13 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1882 | 1 | 14 | 0.16 |
| 1882 | 1 | 15 | 0.00 |
| 1882 | 1 | 16 | 0.00 |
| 1882 | 1 | 17 | 0.16 |
| 1882 | 1 | 18 | 0.20 |
| 1882 | 1 | 19 | 0.30 |
| 1882 | 1 | 20 | 0.04 |
| 1882 | 1 | 21 | 0.00 |
| 1882 | 1 | 22 | 0.78 |
| 1882 | 1 | 23 | 0.52 |
| 1882 | 1 | 24 | 0.00 |
| 1882 | 1 | 25 | 0.20 |
| 1882 | 1 | 26 | 0.24 |
| 1882 | 1 | 27 | 0.16 |
| 1882 | 1 | 28 | 0.10 |
| 1882 | 1 | 29 | 0.00 |
| 1882 | 1 | 30 | 0.64 |
| 1882 | 1 | 31 | 0.20 |
| 1882 | 2 | 1  | 0.18 |
| 1882 | 2 | 2  | 0.38 |
| 1882 | 2 | 3  | 0.00 |
| 1882 | 2 | 4  | 1.00 |
| 1882 | 2 | 5  | 0.60 |
| 1882 | 2 | 6  | 0.44 |
| 1882 | 2 | 7  | 0.00 |
| 1882 | 2 | 8  | 0.26 |
| 1882 | 2 | 9  | 0.54 |
| 1882 | 2 | 10 | 0.50 |
| 1882 | 2 | 11 | 0.10 |
| 1882 | 2 | 12 | 0.16 |
| 1882 | 2 | 13 | 0.28 |
| 1882 | 2 | 14 | 1.18 |
| 1882 | 2 | 15 | 0.00 |
| 1882 | 2 | 16 | 0.40 |
| 1882 | 2 | 17 | 0.00 |
| 1882 | 2 | 18 | 0.00 |
| 1882 | 2 | 19 | 0.00 |
| 1882 | 2 | 20 | 0.30 |
| 1882 | 2 | 21 | 0.00 |
| 1882 | 2 | 22 | 0.64 |
| 1882 | 2 | 23 | 0.00 |
| 1882 | 2 | 24 | 0.00 |
| 1882 | 2 | 25 | 1.21 |

|      |   |    |      |
|------|---|----|------|
| 1882 | 2 | 26 | 0.00 |
| 1882 | 2 | 27 | 0.94 |
| 1882 | 2 | 28 | 0.91 |
| 1882 | 3 | 1  | 0.00 |
| 1882 | 3 | 2  | 0.56 |
| 1882 | 3 | 3  | 0.40 |
| 1882 | 3 | 4  | 0.00 |
| 1882 | 3 | 5  | 0.00 |
| 1882 | 3 | 6  | 0.00 |
| 1882 | 3 | 7  | 0.20 |
| 1882 | 3 | 8  | 0.09 |
| 1882 | 3 | 9  | 0.40 |
| 1882 | 3 | 10 | 0.00 |
| 1882 | 3 | 11 | 0.00 |
| 1882 | 3 | 12 | 0.00 |
| 1882 | 3 | 13 | 0.00 |
| 1882 | 3 | 14 | 0.05 |
| 1882 | 3 | 15 | 0.03 |
| 1882 | 3 | 16 | 0.00 |
| 1882 | 3 | 17 | 0.20 |
| 1882 | 3 | 18 | 0.06 |
| 1882 | 3 | 19 | 0.60 |
| 1882 | 3 | 20 | 0.04 |
| 1882 | 3 | 21 | 0.03 |
| 1882 | 3 | 22 | 0.02 |
| 1882 | 3 | 23 | 0.08 |
| 1882 | 3 | 24 | 0.40 |
| 1882 | 3 | 25 | 0.15 |
| 1882 | 3 | 26 | 0.26 |
| 1882 | 3 | 27 | 0.24 |
| 1882 | 3 | 28 | 0.34 |
| 1882 | 3 | 29 | 0.00 |
| 1882 | 3 | 30 | 0.02 |
| 1882 | 3 | 31 | 0.40 |
| 1882 | 4 | 1  | 0.60 |
| 1882 | 4 | 2  | 0.40 |
| 1882 | 4 | 3  | 0.00 |
| 1882 | 4 | 4  | 0.06 |
| 1882 | 4 | 5  | 0.10 |
| 1882 | 4 | 6  | 0.18 |
| 1882 | 4 | 7  | 0.00 |
| 1882 | 4 | 8  | 0.12 |
| 1882 | 4 | 9  | 0.28 |

|      |   |    |      |
|------|---|----|------|
| 1882 | 4 | 10 | 0.00 |
| 1882 | 4 | 11 | 0.12 |
| 1882 | 4 | 12 | 0.00 |
| 1882 | 4 | 13 | 0.00 |
| 1882 | 4 | 14 | 0.30 |
| 1882 | 4 | 15 | 0.52 |
| 1882 | 4 | 16 | 0.18 |
| 1882 | 4 | 17 | 0.04 |
| 1882 | 4 | 18 | 0.28 |
| 1882 | 4 | 19 | 0.72 |
| 1882 | 4 | 20 | 0.16 |
| 1882 | 4 | 21 | 0.24 |
| 1882 | 4 | 22 | 1.12 |
| 1882 | 4 | 23 | 0.08 |
| 1882 | 4 | 24 | 0.66 |
| 1882 | 4 | 25 | 0.50 |
| 1882 | 4 | 26 | 0.20 |
| 1882 | 4 | 27 | 0.00 |
| 1882 | 4 | 28 | 0.00 |
| 1882 | 4 | 29 | 0.00 |
| 1882 | 4 | 30 | 0.00 |
| 1882 | 5 | 1  | 0.00 |
| 1882 | 5 | 2  | 0.00 |
| 1882 | 5 | 3  | 0.00 |
| 1882 | 5 | 4  | 0.00 |
| 1882 | 5 | 5  | 0.00 |
| 1882 | 5 | 6  | 0.12 |
| 1882 | 5 | 7  | 0.32 |
| 1882 | 5 | 8  | 0.00 |
| 1882 | 5 | 9  | 0.12 |
| 1882 | 5 | 10 | 0.10 |
| 1882 | 5 | 11 | 0.00 |
| 1882 | 5 | 12 | 0.00 |
| 1882 | 5 | 13 | 0.82 |
| 1882 | 5 | 14 | 0.00 |
| 1882 | 5 | 15 | 0.00 |
| 1882 | 5 | 16 | 0.52 |
| 1882 | 5 | 17 | 0.00 |
| 1882 | 5 | 18 | 0.18 |
| 1882 | 5 | 19 | 0.00 |
| 1882 | 5 | 20 | 0.00 |
| 1882 | 5 | 21 | 0.00 |
| 1882 | 5 | 22 | 0.00 |



|      |   |    |      |
|------|---|----|------|
| 1882 | 5 | 23 | 0.00 |
| 1882 | 5 | 24 | 0.00 |
| 1882 | 5 | 25 | 0.00 |
| 1882 | 5 | 26 | 0.00 |
| 1882 | 5 | 27 | 0.00 |
| 1882 | 5 | 28 | 0.00 |
| 1882 | 5 | 29 | 0.00 |
| 1882 | 5 | 30 | 0.00 |
| 1882 | 5 | 31 | 0.00 |
| 1882 | 6 | 1  | 0.00 |
| 1882 | 6 | 2  | 0.00 |
| 1882 | 6 | 3  | 0.00 |
| 1882 | 6 | 4  | 0.00 |
| 1882 | 6 | 5  | 0.00 |
| 1882 | 6 | 6  | 0.70 |
| 1882 | 6 | 7  | 0.10 |
| 1882 | 6 | 8  | 0.16 |
| 1882 | 6 | 9  | 0.00 |
| 1882 | 6 | 10 | 0.00 |
| 1882 | 6 | 11 | 0.08 |
| 1882 | 6 | 12 | 0.00 |
| 1882 | 6 | 13 | 0.00 |
| 1882 | 6 | 14 | 0.00 |
| 1882 | 6 | 15 | 0.00 |
| 1882 | 6 | 16 | 0.10 |
| 1882 | 6 | 17 | 0.00 |
| 1882 | 6 | 18 | 0.00 |
| 1882 | 6 | 19 | 0.52 |
| 1882 | 6 | 20 | 0.08 |
| 1882 | 6 | 21 | 0.04 |
| 1882 | 6 | 22 | 0.00 |
| 1882 | 6 | 23 | 0.00 |
| 1882 | 6 | 24 | 0.00 |
| 1882 | 6 | 25 | 0.00 |
| 1882 | 6 | 26 | 0.00 |
| 1882 | 6 | 27 | 0.06 |
| 1882 | 6 | 28 | 0.00 |
| 1882 | 6 | 29 | 0.00 |
| 1882 | 6 | 30 | 0.00 |
| 1882 | 7 | 1  | 0.00 |
| 1882 | 7 | 2  | 0.00 |
| 1882 | 7 | 3  | 0.00 |
| 1882 | 7 | 4  | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1882 | 7 | 5  | 0.00 |
| 1882 | 7 | 6  | 0.00 |
| 1882 | 7 | 7  | 0.04 |
| 1882 | 7 | 8  | 0.00 |
| 1882 | 7 | 9  | 0.04 |
| 1882 | 7 | 10 | 0.00 |
| 1882 | 7 | 11 | 0.00 |
| 1882 | 7 | 12 | 0.00 |
| 1882 | 7 | 13 | 0.00 |
| 1882 | 7 | 14 | 0.00 |
| 1882 | 7 | 15 | 0.00 |
| 1882 | 7 | 16 | 0.00 |
| 1882 | 7 | 17 | 0.00 |
| 1882 | 7 | 18 | 0.00 |
| 1882 | 7 | 19 | 0.00 |
| 1882 | 7 | 20 | 0.00 |
| 1882 | 7 | 21 | 0.00 |
| 1882 | 7 | 22 | 0.00 |
| 1882 | 7 | 23 | 0.00 |
| 1882 | 7 | 24 | 0.12 |
| 1882 | 7 | 25 | 0.00 |
| 1882 | 7 | 26 | 0.12 |
| 1882 | 7 | 27 | 0.16 |
| 1882 | 7 | 28 | 0.00 |
| 1882 | 7 | 29 | 0.00 |
| 1882 | 7 | 30 | 0.38 |
| 1882 | 7 | 31 | 0.00 |
| 1882 | 8 | 1  | 0.08 |
| 1882 | 8 | 2  | 0.00 |
| 1882 | 8 | 3  | 0.00 |
| 1882 | 8 | 4  | 0.00 |
| 1882 | 8 | 5  | 0.00 |
| 1882 | 8 | 6  | 0.00 |
| 1882 | 8 | 7  | 0.00 |
| 1882 | 8 | 8  | 0.00 |
| 1882 | 8 | 9  | 0.00 |
| 1882 | 8 | 10 | 0.00 |
| 1882 | 8 | 11 | 0.00 |
| 1882 | 8 | 12 | 0.00 |
| 1882 | 8 | 13 | 0.00 |
| 1882 | 8 | 14 | 0.00 |
| 1882 | 8 | 15 | 0.00 |
| 1882 | 8 | 16 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1882 | 8 | 17 | 0.00 |
| 1882 | 8 | 18 | 0.00 |
| 1882 | 8 | 19 | 0.00 |
| 1882 | 8 | 20 | 0.00 |
| 1882 | 8 | 21 | 0.00 |
| 1882 | 8 | 22 | 0.02 |
| 1882 | 8 | 23 | 0.00 |
| 1882 | 8 | 24 | 0.00 |
| 1882 | 8 | 25 | 0.42 |
| 1882 | 8 | 26 | 0.00 |
| 1882 | 8 | 27 | 0.00 |
| 1882 | 8 | 28 | 0.00 |
| 1882 | 8 | 29 | 0.00 |
| 1882 | 8 | 30 | 0.00 |
| 1882 | 8 | 31 | 0.00 |
| 1882 | 9 | 1  | 0.00 |
| 1882 | 9 | 2  | 0.00 |
| 1882 | 9 | 3  | 0.00 |
| 1882 | 9 | 4  | 0.00 |
| 1882 | 9 | 5  | 0.00 |
| 1882 | 9 | 6  | 0.00 |
| 1882 | 9 | 7  | 0.00 |
| 1882 | 9 | 8  | 0.00 |
| 1882 | 9 | 9  | 0.00 |
| 1882 | 9 | 10 | 0.00 |
| 1882 | 9 | 11 | 2.16 |
| 1882 | 9 | 12 | 0.36 |
| 1882 | 9 | 13 | 0.00 |
| 1882 | 9 | 14 | 0.00 |
| 1882 | 9 | 15 | 0.16 |
| 1882 | 9 | 16 | 0.00 |
| 1882 | 9 | 17 | 0.00 |
| 1882 | 9 | 18 | 0.00 |
| 1882 | 9 | 19 | 0.00 |
| 1882 | 9 | 20 | 0.00 |
| 1882 | 9 | 21 | 0.00 |
| 1882 | 9 | 22 | 0.00 |
| 1882 | 9 | 23 | 0.00 |
| 1882 | 9 | 24 | 0.00 |
| 1882 | 9 | 25 | 0.00 |
| 1882 | 9 | 26 | 0.00 |
| 1882 | 9 | 27 | 0.00 |
| 1882 | 9 | 28 | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1882 | 9  | 29 | 0.00 |
| 1882 | 9  | 30 | 0.00 |
| 1882 | 10 | 1  | 0.00 |
| 1882 | 10 | 2  | 0.00 |
| 1882 | 10 | 3  | 0.00 |
| 1882 | 10 | 4  | 0.80 |
| 1882 | 10 | 5  | 0.48 |
| 1882 | 10 | 6  | 0.00 |
| 1882 | 10 | 7  | 2.70 |
| 1882 | 10 | 8  | 0.58 |
| 1882 | 10 | 9  | 0.58 |
| 1882 | 10 | 10 | 0.74 |
| 1882 | 10 | 11 | 0.52 |
| 1882 | 10 | 12 | 0.64 |
| 1882 | 10 | 13 | 0.00 |
| 1882 | 10 | 14 | 0.24 |
| 1882 | 10 | 15 | 1.14 |
| 1882 | 10 | 16 | 0.00 |
| 1882 | 10 | 17 | 0.00 |
| 1882 | 10 | 18 | 0.00 |
| 1882 | 10 | 19 | 0.00 |
| 1882 | 10 | 20 | 0.00 |
| 1882 | 10 | 21 | 0.00 |
| 1882 | 10 | 22 | 0.00 |
| 1882 | 10 | 23 | 0.08 |
| 1882 | 10 | 24 | 0.14 |
| 1882 | 10 | 25 | 0.40 |
| 1882 | 10 | 26 | 0.82 |
| 1882 | 10 | 27 | 0.28 |
| 1882 | 10 | 28 | 0.76 |
| 1882 | 10 | 29 | 0.00 |
| 1882 | 10 | 30 | 0.00 |
| 1882 | 10 | 31 | 0.00 |
| 1882 | 11 | 1  | 0.48 |
| 1882 | 11 | 2  | 0.16 |
| 1882 | 11 | 3  | 0.06 |
| 1882 | 11 | 4  | 0.14 |
| 1882 | 11 | 5  | 1.30 |
| 1882 | 11 | 6  | 0.00 |
| 1882 | 11 | 7  | 0.00 |
| 1882 | 11 | 8  | 0.00 |
| 1882 | 11 | 9  | 0.00 |
| 1882 | 11 | 10 | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1882 | 11 | 11 | 0.00 |
| 1882 | 11 | 12 | 0.00 |
| 1882 | 11 | 13 | 0.00 |
| 1882 | 11 | 14 | 1.44 |
| 1882 | 11 | 15 | 0.12 |
| 1882 | 11 | 16 | 0.00 |
| 1882 | 11 | 17 | 0.00 |
| 1882 | 11 | 18 | 0.00 |
| 1882 | 11 | 19 | 0.60 |
| 1882 | 11 | 20 | 0.04 |
| 1882 | 11 | 21 | 0.72 |
| 1882 | 11 | 22 | 0.82 |
| 1882 | 11 | 23 | 0.00 |
| 1882 | 11 | 24 | 0.14 |
| 1882 | 11 | 25 | 0.12 |
| 1882 | 11 | 26 | 0.66 |
| 1882 | 11 | 27 | 0.00 |
| 1882 | 11 | 28 | 0.00 |
| 1882 | 11 | 29 | 0.00 |
| 1882 | 11 | 30 | 1.02 |
| 1882 | 12 | 1  | 0.00 |
| 1882 | 12 | 2  | 0.00 |
| 1882 | 12 | 3  | 0.30 |
| 1882 | 12 | 4  | 1.00 |
| 1882 | 12 | 5  | 0.12 |
| 1882 | 12 | 6  | 0.08 |
| 1882 | 12 | 7  | 1.08 |
| 1882 | 12 | 8  | 0.60 |
| 1882 | 12 | 9  | 0.30 |
| 1882 | 12 | 10 | 0.50 |
| 1882 | 12 | 11 | 0.74 |
| 1882 | 12 | 12 | 0.50 |
| 1882 | 12 | 13 | 1.92 |
| 1882 | 12 | 14 | 0.28 |
| 1882 | 12 | 15 | 0.14 |
| 1882 | 12 | 16 | 0.08 |
| 1882 | 12 | 17 | 0.88 |
| 1882 | 12 | 18 | 0.20 |
| 1882 | 12 | 19 | 0.10 |
| 1882 | 12 | 20 | 0.44 |
| 1882 | 12 | 21 | 0.80 |
| 1882 | 12 | 22 | 1.34 |
| 1882 | 12 | 23 | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1882 | 12 | 24 | 0.30 |
| 1882 | 12 | 25 | 0.00 |
| 1882 | 12 | 26 | 0.00 |
| 1882 | 12 | 27 | 0.76 |
| 1882 | 12 | 28 | 0.00 |
| 1882 | 12 | 29 | 0.00 |
| 1882 | 12 | 30 | 0.00 |
| 1882 | 12 | 31 | 0.00 |
| 1883 | 1  | 1  | 0.00 |
| 1883 | 1  | 2  | 0.00 |
| 1883 | 1  | 3  | 0.08 |
| 1883 | 1  | 4  | 0.48 |
| 1883 | 1  | 5  | 1.68 |
| 1883 | 1  | 6  | 0.74 |
| 1883 | 1  | 7  | 0.24 |
| 1883 | 1  | 8  | 0.00 |
| 1883 | 1  | 9  | 0.70 |
| 1883 | 1  | 10 | 0.30 |
| 1883 | 1  | 11 | 0.08 |
| 1883 | 1  | 12 | 0.00 |
| 1883 | 1  | 13 | 0.46 |
| 1883 | 1  | 14 | 0.08 |
| 1883 | 1  | 15 | 0.34 |
| 1883 | 1  | 16 | 0.00 |
| 1883 | 1  | 17 | 0.00 |
| 1883 | 1  | 18 | 0.00 |
| 1883 | 1  | 19 | 0.12 |
| 1883 | 1  | 20 | 0.04 |
| 1883 | 1  | 21 | 0.00 |
| 1883 | 1  | 22 | 0.68 |
| 1883 | 1  | 23 | 0.00 |
| 1883 | 1  | 24 | 0.34 |
| 1883 | 1  | 25 | 0.24 |
| 1883 | 1  | 26 | 1.08 |
| 1883 | 1  | 27 | 0.40 |
| 1883 | 1  | 28 | 1.04 |
| 1883 | 1  | 29 | 0.04 |
| 1883 | 1  | 30 | 0.22 |
| 1883 | 1  | 31 | 0.00 |
| 1883 | 2  | 1  | 0.00 |
| 1883 | 2  | 2  | 0.00 |
| 1883 | 2  | 3  | 0.00 |
| 1883 | 2  | 4  | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1883 | 2 | 5  | 0.00 |
| 1883 | 2 | 6  | 0.00 |
| 1883 | 2 | 7  | 0.00 |
| 1883 | 2 | 8  | 0.00 |
| 1883 | 2 | 9  | 0.00 |
| 1883 | 2 | 10 | 0.00 |
| 1883 | 2 | 11 | 0.00 |
| 1883 | 2 | 12 | 1.20 |
| 1883 | 2 | 13 | 0.86 |
| 1883 | 2 | 14 | 0.56 |
| 1883 | 2 | 15 | 0.08 |
| 1883 | 2 | 16 | 0.00 |
| 1883 | 2 | 17 | 0.00 |
| 1883 | 2 | 18 | 1.30 |
| 1883 | 2 | 19 | 1.64 |
| 1883 | 2 | 20 | 0.00 |
| 1883 | 2 | 21 | 0.08 |
| 1883 | 2 | 22 | 0.20 |
| 1883 | 2 | 23 | 0.00 |
| 1883 | 2 | 24 | 0.00 |
| 1883 | 2 | 25 | 0.00 |
| 1883 | 2 | 26 | 0.00 |
| 1883 | 2 | 27 | 0.00 |
| 1883 | 2 | 28 | 0.44 |
| 1883 | 3 | 1  | 0.00 |
| 1883 | 3 | 2  | 0.00 |
| 1883 | 3 | 3  | 0.00 |
| 1883 | 3 | 4  | 0.12 |
| 1883 | 3 | 5  | 0.00 |
| 1883 | 3 | 6  | 0.00 |
| 1883 | 3 | 7  | 0.00 |
| 1883 | 3 | 8  | 0.12 |
| 1883 | 3 | 9  | 0.00 |
| 1883 | 3 | 10 | 0.00 |
| 1883 | 3 | 11 | 0.00 |
| 1883 | 3 | 12 | 0.00 |
| 1883 | 3 | 13 | 0.00 |
| 1883 | 3 | 14 | 0.00 |
| 1883 | 3 | 15 | 0.00 |
| 1883 | 3 | 16 | 0.00 |
| 1883 | 3 | 17 | 0.00 |
| 1883 | 3 | 18 | 0.00 |
| 1883 | 3 | 19 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1883 | 3 | 20 | 0.00 |
| 1883 | 3 | 21 | 0.00 |
| 1883 | 3 | 22 | 0.00 |
| 1883 | 3 | 23 | 0.12 |
| 1883 | 3 | 24 | 0.20 |
| 1883 | 3 | 25 | 0.00 |
| 1883 | 3 | 26 | 0.08 |
| 1883 | 3 | 27 | 0.56 |
| 1883 | 3 | 28 | 0.22 |
| 1883 | 3 | 29 | 0.36 |
| 1883 | 3 | 30 | 0.30 |
| 1883 | 3 | 31 | 0.36 |
| 1883 | 4 | 1  | 0.06 |
| 1883 | 4 | 2  | 0.72 |
| 1883 | 4 | 3  | 0.02 |
| 1883 | 4 | 4  | 0.00 |
| 1883 | 4 | 5  | 0.00 |
| 1883 | 4 | 6  | 0.00 |
| 1883 | 4 | 7  | 0.86 |
| 1883 | 4 | 8  | 0.41 |
| 1883 | 4 | 9  | 0.06 |
| 1883 | 4 | 10 | 0.41 |
| 1883 | 4 | 11 | 0.80 |
| 1883 | 4 | 12 | 0.30 |
| 1883 | 4 | 13 | 0.04 |
| 1883 | 4 | 14 | 0.11 |
| 1883 | 4 | 15 | 0.72 |
| 1883 | 4 | 16 | 0.02 |
| 1883 | 4 | 17 | 0.00 |
| 1883 | 4 | 18 | 0.83 |
| 1883 | 4 | 19 | 0.46 |
| 1883 | 4 | 20 | 0.04 |
| 1883 | 4 | 21 | 0.26 |
| 1883 | 4 | 22 | 0.04 |
| 1883 | 4 | 23 | 0.00 |
| 1883 | 4 | 24 | 0.00 |
| 1883 | 4 | 25 | 0.00 |
| 1883 | 4 | 26 | 0.00 |
| 1883 | 4 | 27 | 0.00 |
| 1883 | 4 | 28 | 0.00 |
| 1883 | 4 | 29 | 0.17 |
| 1883 | 4 | 30 | 0.20 |
| 1883 | 5 | 1  | 0.18 |



|      |   |    |      |
|------|---|----|------|
| 1883 | 5 | 2  | 0.08 |
| 1883 | 5 | 3  | 0.00 |
| 1883 | 5 | 4  | 0.40 |
| 1883 | 5 | 5  | 0.64 |
| 1883 | 5 | 6  | 0.00 |
| 1883 | 5 | 7  | 0.00 |
| 1883 | 5 | 8  | 0.00 |
| 1883 | 5 | 9  | 0.00 |
| 1883 | 5 | 10 | 0.00 |
| 1883 | 5 | 11 | 0.00 |
| 1883 | 5 | 12 | 0.00 |
| 1883 | 5 | 13 | 0.96 |
| 1883 | 5 | 14 | 0.40 |
| 1883 | 5 | 15 | 0.00 |
| 1883 | 5 | 16 | 0.00 |
| 1883 | 5 | 17 | 0.00 |
| 1883 | 5 | 18 | 0.24 |
| 1883 | 5 | 19 | 0.00 |
| 1883 | 5 | 20 | 0.00 |
| 1883 | 5 | 21 | 0.00 |
| 1883 | 5 | 22 | 0.00 |
| 1883 | 5 | 23 | 0.08 |
| 1883 | 5 | 24 | 0.04 |
| 1883 | 5 | 25 | 0.12 |
| 1883 | 5 | 26 | 0.00 |
| 1883 | 5 | 27 | 0.00 |
| 1883 | 5 | 28 | 0.00 |
| 1883 | 5 | 29 | 0.00 |
| 1883 | 5 | 30 | 0.00 |
| 1883 | 5 | 31 | 0.00 |
| 1883 | 6 | 1  | 0.00 |
| 1883 | 6 | 2  | 0.00 |
| 1883 | 6 | 3  | 0.06 |
| 1883 | 6 | 4  | 0.02 |
| 1883 | 6 | 5  | 0.00 |
| 1883 | 6 | 6  | 0.00 |
| 1883 | 6 | 7  | 0.00 |
| 1883 | 6 | 8  | 0.00 |
| 1883 | 6 | 9  | 0.00 |
| 1883 | 6 | 10 | 0.00 |
| 1883 | 6 | 11 | 0.00 |
| 1883 | 6 | 12 | 0.00 |
| 1883 | 6 | 13 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1883 | 6 | 14 | 0.00 |
| 1883 | 6 | 15 | 0.00 |
| 1883 | 6 | 16 | 0.00 |
| 1883 | 6 | 17 | 0.00 |
| 1883 | 6 | 18 | 0.00 |
| 1883 | 6 | 19 | 0.00 |
| 1883 | 6 | 20 | 0.00 |
| 1883 | 6 | 21 | 0.00 |
| 1883 | 6 | 22 | 0.00 |
| 1883 | 6 | 23 | 0.00 |
| 1883 | 6 | 24 | 0.00 |
| 1883 | 6 | 25 | 0.00 |
| 1883 | 6 | 26 | 0.00 |
| 1883 | 6 | 27 | 0.00 |
| 1883 | 6 | 28 | 0.00 |
| 1883 | 6 | 29 | 0.00 |
| 1883 | 6 | 30 | 0.00 |
| 1883 | 7 | 1  | 0.00 |
| 1883 | 7 | 2  | 0.00 |
| 1883 | 7 | 3  | 0.00 |
| 1883 | 7 | 4  | 0.00 |
| 1883 | 7 | 5  | 0.00 |
| 1883 | 7 | 6  | 0.00 |
| 1883 | 7 | 7  | 0.00 |
| 1883 | 7 | 8  | 0.00 |
| 1883 | 7 | 9  | 0.00 |
| 1883 | 7 | 10 | 0.00 |
| 1883 | 7 | 11 | 0.00 |
| 1883 | 7 | 12 | 0.00 |
| 1883 | 7 | 13 | 0.00 |
| 1883 | 7 | 14 | 0.00 |
| 1883 | 7 | 15 | 0.00 |
| 1883 | 7 | 16 | 0.00 |
| 1883 | 7 | 17 | 0.00 |
| 1883 | 7 | 18 | 0.00 |
| 1883 | 7 | 19 | 0.00 |
| 1883 | 7 | 20 | 0.00 |
| 1883 | 7 | 21 | 0.00 |
| 1883 | 7 | 22 | 0.00 |
| 1883 | 7 | 23 | 0.00 |
| 1883 | 7 | 24 | 0.00 |
| 1883 | 7 | 25 | 0.00 |
| 1883 | 7 | 26 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1883 | 7 | 27 | 0.00 |
| 1883 | 7 | 28 | 0.00 |
| 1883 | 7 | 29 | 0.00 |
| 1883 | 7 | 30 | 0.00 |
| 1883 | 7 | 31 | 0.00 |
| 1883 | 8 | 1  | 0.00 |
| 1883 | 8 | 2  | 0.00 |
| 1883 | 8 | 3  | 0.00 |
| 1883 | 8 | 4  | 0.00 |
| 1883 | 8 | 5  | 0.00 |
| 1883 | 8 | 6  | 0.00 |
| 1883 | 8 | 7  | 0.00 |
| 1883 | 8 | 8  | 0.00 |
| 1883 | 8 | 9  | 0.00 |
| 1883 | 8 | 10 | 0.00 |
| 1883 | 8 | 11 | 0.00 |
| 1883 | 8 | 12 | 0.00 |
| 1883 | 8 | 13 | 0.00 |
| 1883 | 8 | 14 | 0.00 |
| 1883 | 8 | 15 | 0.00 |
| 1883 | 8 | 16 | 0.00 |
| 1883 | 8 | 17 | 0.00 |
| 1883 | 8 | 18 | 0.00 |
| 1883 | 8 | 19 | 0.00 |
| 1883 | 8 | 20 | 0.00 |
| 1883 | 8 | 21 | 0.00 |
| 1883 | 8 | 22 | 0.00 |
| 1883 | 8 | 23 | 0.00 |
| 1883 | 8 | 24 | 0.00 |
| 1883 | 8 | 25 | 0.00 |
| 1883 | 8 | 26 | 0.00 |
| 1883 | 8 | 27 | 0.00 |
| 1883 | 8 | 28 | 0.00 |
| 1883 | 8 | 29 | 0.00 |
| 1883 | 8 | 30 | 0.00 |
| 1883 | 8 | 31 | 0.00 |
| 1883 | 9 | 1  | 0.00 |
| 1883 | 9 | 2  | 0.00 |
| 1883 | 9 | 3  | 0.00 |
| 1883 | 9 | 4  | 0.00 |
| 1883 | 9 | 5  | 0.00 |
| 1883 | 9 | 6  | 0.26 |
| 1883 | 9 | 7  | 0.24 |

|      |    |    |      |
|------|----|----|------|
| 1883 | 9  | 8  | 0.76 |
| 1883 | 9  | 9  | 0.35 |
| 1883 | 9  | 10 | 0.12 |
| 1883 | 9  | 11 | 0.01 |
| 1883 | 9  | 12 | 0.01 |
| 1883 | 9  | 13 | 0.00 |
| 1883 | 9  | 14 | 0.00 |
| 1883 | 9  | 15 | 0.00 |
| 1883 | 9  | 16 | 0.00 |
| 1883 | 9  | 17 | 0.43 |
| 1883 | 9  | 18 | 0.01 |
| 1883 | 9  | 19 | 0.00 |
| 1883 | 9  | 20 | 0.00 |
| 1883 | 9  | 21 | 0.00 |
| 1883 | 9  | 22 | 0.00 |
| 1883 | 9  | 23 | 0.00 |
| 1883 | 9  | 24 | 0.00 |
| 1883 | 9  | 25 | 0.00 |
| 1883 | 9  | 26 | 0.00 |
| 1883 | 9  | 27 | 0.00 |
| 1883 | 9  | 28 | 0.31 |
| 1883 | 9  | 29 | 0.06 |
| 1883 | 9  | 30 | 0.59 |
| 1883 | 10 | 1  | 0.48 |
| 1883 | 10 | 2  | 0.00 |
| 1883 | 10 | 3  | 0.00 |
| 1883 | 10 | 4  | 0.15 |
| 1883 | 10 | 5  | 0.30 |
| 1883 | 10 | 6  | 0.00 |
| 1883 | 10 | 7  | 0.28 |
| 1883 | 10 | 8  | 0.77 |
| 1883 | 10 | 9  | 0.12 |
| 1883 | 10 | 10 | 0.16 |
| 1883 | 10 | 11 | 0.00 |
| 1883 | 10 | 12 | 0.09 |
| 1883 | 10 | 13 | 0.05 |
| 1883 | 10 | 14 | 0.00 |
| 1883 | 10 | 15 | 0.00 |
| 1883 | 10 | 16 | 0.03 |
| 1883 | 10 | 17 | 0.12 |
| 1883 | 10 | 18 | 0.23 |
| 1883 | 10 | 19 | 0.06 |
| 1883 | 10 | 20 | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1883 | 10 | 21 | 0.00 |
| 1883 | 10 | 22 | 0.00 |
| 1883 | 10 | 23 | 0.00 |
| 1883 | 10 | 24 | 0.74 |
| 1883 | 10 | 25 | 0.66 |
| 1883 | 10 | 26 | 0.54 |
| 1883 | 10 | 27 | 0.42 |
| 1883 | 10 | 28 | 0.38 |
| 1883 | 10 | 29 | 0.07 |
| 1883 | 10 | 30 | 0.00 |
| 1883 | 10 | 31 | 0.00 |
| 1883 | 11 | 1  | 0.12 |
| 1883 | 11 | 2  | 0.00 |
| 1883 | 11 | 3  | 0.00 |
| 1883 | 11 | 4  | 0.02 |
| 1883 | 11 | 5  | 0.04 |
| 1883 | 11 | 6  | 0.29 |
| 1883 | 11 | 7  | 0.06 |
| 1883 | 11 | 8  | 0.03 |
| 1883 | 11 | 9  | 0.09 |
| 1883 | 11 | 10 | 0.67 |
| 1883 | 11 | 11 | 0.04 |
| 1883 | 11 | 12 | 0.00 |
| 1883 | 11 | 13 | 0.01 |
| 1883 | 11 | 14 | 0.00 |
| 1883 | 11 | 15 | 0.03 |
| 1883 | 11 | 16 | 0.17 |
| 1883 | 11 | 17 | 0.21 |
| 1883 | 11 | 18 | 0.21 |
| 1883 | 11 | 19 | 0.48 |
| 1883 | 11 | 20 | 0.17 |
| 1883 | 11 | 21 | 0.53 |
| 1883 | 11 | 22 | 0.15 |
| 1883 | 11 | 23 | 0.41 |
| 1883 | 11 | 24 | 0.46 |
| 1883 | 11 | 25 | 0.23 |
| 1883 | 11 | 26 | 1.74 |
| 1883 | 11 | 27 | 0.77 |
| 1883 | 11 | 28 | 0.08 |
| 1883 | 11 | 29 | 0.53 |
| 1883 | 11 | 30 | 0.80 |
| 1883 | 12 | 1  | 0.13 |
| 1883 | 12 | 2  | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1883 | 12 | 3  | 0.00 |
| 1883 | 12 | 4  | 0.10 |
| 1883 | 12 | 5  | 0.47 |
| 1883 | 12 | 6  | 0.13 |
| 1883 | 12 | 7  | 0.02 |
| 1883 | 12 | 8  | 0.00 |
| 1883 | 12 | 9  | 0.53 |
| 1883 | 12 | 10 | 0.11 |
| 1883 | 12 | 11 | 0.32 |
| 1883 | 12 | 12 | 0.09 |
| 1883 | 12 | 13 | 0.00 |
| 1883 | 12 | 14 | 0.00 |
| 1883 | 12 | 15 | 0.00 |
| 1883 | 12 | 16 | 0.00 |
| 1883 | 12 | 17 | 0.00 |
| 1883 | 12 | 18 | 0.05 |
| 1883 | 12 | 19 | 0.30 |
| 1883 | 12 | 20 | 0.09 |
| 1883 | 12 | 21 | 0.53 |
| 1883 | 12 | 22 | 0.38 |
| 1883 | 12 | 23 | 0.26 |
| 1883 | 12 | 24 | 0.66 |
| 1883 | 12 | 25 | 0.28 |
| 1883 | 12 | 26 | 0.84 |
| 1883 | 12 | 27 | 0.16 |
| 1883 | 12 | 28 | 0.20 |
| 1883 | 12 | 29 | 0.22 |
| 1883 | 12 | 30 | 0.00 |
| 1883 | 12 | 31 | 0.00 |
| 1884 | 1  | 1  | 0.01 |
| 1884 | 1  | 2  | 0.40 |
| 1884 | 1  | 3  | 2.17 |
| 1884 | 1  | 4  | 0.56 |
| 1884 | 1  | 5  | 0.34 |
| 1884 | 1  | 6  | 0.33 |
| 1884 | 1  | 7  | 0.32 |
| 1884 | 1  | 8  | 0.30 |
| 1884 | 1  | 9  | 0.03 |
| 1884 | 1  | 10 | 0.00 |
| 1884 | 1  | 11 | 0.05 |
| 1884 | 1  | 12 | 0.45 |
| 1884 | 1  | 13 | 0.00 |
| 1884 | 1  | 14 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1884 | 1 | 15 | 0.00 |
| 1884 | 1 | 16 | 0.00 |
| 1884 | 1 | 17 | 0.08 |
| 1884 | 1 | 18 | 0.04 |
| 1884 | 1 | 19 | 0.00 |
| 1884 | 1 | 20 | 0.00 |
| 1884 | 1 | 21 | 0.00 |
| 1884 | 1 | 22 | 0.00 |
| 1884 | 1 | 23 | 0.00 |
| 1884 | 1 | 24 | 0.00 |
| 1884 | 1 | 25 | 0.90 |
| 1884 | 1 | 26 | 0.31 |
| 1884 | 1 | 27 | 0.00 |
| 1884 | 1 | 28 | 0.16 |
| 1884 | 1 | 29 | 0.00 |
| 1884 | 1 | 30 | 0.00 |
| 1884 | 1 | 31 | 0.00 |
| 1884 | 2 | 1  | 0.00 |
| 1884 | 2 | 2  | 0.04 |
| 1884 | 2 | 3  | 0.58 |
| 1884 | 2 | 4  | 0.22 |
| 1884 | 2 | 5  | 0.00 |
| 1884 | 2 | 6  | 0.00 |
| 1884 | 2 | 7  | 0.00 |
| 1884 | 2 | 8  | 0.60 |
| 1884 | 2 | 9  | 0.12 |
| 1884 | 2 | 10 | 0.00 |
| 1884 | 2 | 11 | 0.00 |
| 1884 | 2 | 12 | 0.00 |
| 1884 | 2 | 13 | 0.00 |
| 1884 | 2 | 14 | 0.00 |
| 1884 | 2 | 15 | 0.00 |
| 1884 | 2 | 16 | 0.00 |
| 1884 | 2 | 17 | 0.07 |
| 1884 | 2 | 18 | 0.26 |
| 1884 | 2 | 19 | 0.76 |
| 1884 | 2 | 20 | 0.44 |
| 1884 | 2 | 21 | 0.49 |
| 1884 | 2 | 22 | 0.28 |
| 1884 | 2 | 23 | 1.11 |
| 1884 | 2 | 24 | 0.23 |
| 1884 | 2 | 25 | 0.00 |
| 1884 | 2 | 26 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1884 | 2 | 27 | 0.00 |
| 1884 | 2 | 28 | 0.00 |
| 1884 | 2 | 29 | 0.00 |
| 1884 | 3 | 1  | 0.00 |
| 1884 | 3 | 2  | 0.00 |
| 1884 | 3 | 3  | 0.00 |
| 1884 | 3 | 4  | 0.05 |
| 1884 | 3 | 5  | 0.03 |
| 1884 | 3 | 6  | 0.00 |
| 1884 | 3 | 7  | 0.00 |
| 1884 | 3 | 8  | 0.00 |
| 1884 | 3 | 9  | 0.00 |
| 1884 | 3 | 10 | 0.05 |
| 1884 | 3 | 11 | 0.18 |
| 1884 | 3 | 12 | 0.08 |
| 1884 | 3 | 13 | 0.00 |
| 1884 | 3 | 14 | 0.00 |
| 1884 | 3 | 15 | 0.00 |
| 1884 | 3 | 16 | 0.03 |
| 1884 | 3 | 17 | 0.05 |
| 1884 | 3 | 18 | 0.16 |
| 1884 | 3 | 19 | 0.04 |
| 1884 | 3 | 20 | 0.00 |
| 1884 | 3 | 21 | 0.14 |
| 1884 | 3 | 22 | 0.42 |
| 1884 | 3 | 23 | 0.05 |
| 1884 | 3 | 24 | 0.09 |
| 1884 | 3 | 25 | 0.77 |
| 1884 | 3 | 26 | 0.00 |
| 1884 | 3 | 27 | 0.04 |
| 1884 | 3 | 28 | 0.00 |
| 1884 | 3 | 29 | 0.00 |
| 1884 | 3 | 30 | 0.00 |
| 1884 | 3 | 31 | 0.00 |
| 1884 | 4 | 1  | 0.28 |
| 1884 | 4 | 2  | 0.92 |
| 1884 | 4 | 3  | 0.28 |
| 1884 | 4 | 4  | 0.00 |
| 1884 | 4 | 5  | 0.00 |
| 1884 | 4 | 6  | 0.00 |
| 1884 | 4 | 7  | 0.00 |
| 1884 | 4 | 8  | 0.00 |
| 1884 | 4 | 9  | 0.03 |



|      |   |    |      |
|------|---|----|------|
| 1884 | 4 | 10 | 0.04 |
| 1884 | 4 | 11 | 0.23 |
| 1884 | 4 | 12 | 0.00 |
| 1884 | 4 | 13 | 0.29 |
| 1884 | 4 | 14 | 0.24 |
| 1884 | 4 | 15 | 0.00 |
| 1884 | 4 | 16 | 0.00 |
| 1884 | 4 | 17 | 0.00 |
| 1884 | 4 | 18 | 0.00 |
| 1884 | 4 | 19 | 0.00 |
| 1884 | 4 | 20 | 0.00 |
| 1884 | 4 | 21 | 0.01 |
| 1884 | 4 | 22 | 0.11 |
| 1884 | 4 | 23 | 0.24 |
| 1884 | 4 | 24 | 0.17 |
| 1884 | 4 | 25 | 0.04 |
| 1884 | 4 | 26 | 0.10 |
| 1884 | 4 | 27 | 0.00 |
| 1884 | 4 | 28 | 0.00 |
| 1884 | 4 | 29 | 0.00 |
| 1884 | 4 | 30 | 0.00 |
| 1884 | 5 | 1  | 0.00 |
| 1884 | 5 | 2  | 0.36 |
| 1884 | 5 | 3  | 0.05 |
| 1884 | 5 | 4  | 0.57 |
| 1884 | 5 | 5  | 0.00 |
| 1884 | 5 | 6  | 0.09 |
| 1884 | 5 | 7  | 0.04 |
| 1884 | 5 | 8  | 0.00 |
| 1884 | 5 | 9  | 0.00 |
| 1884 | 5 | 10 | 0.00 |
| 1884 | 5 | 11 | 0.00 |
| 1884 | 5 | 12 | 0.00 |
| 1884 | 5 | 13 | 0.00 |
| 1884 | 5 | 14 | 0.00 |
| 1884 | 5 | 15 | 0.00 |
| 1884 | 5 | 16 | 0.00 |
| 1884 | 5 | 17 | 0.00 |
| 1884 | 5 | 18 | 0.00 |
| 1884 | 5 | 19 | 0.00 |
| 1884 | 5 | 20 | 0.00 |
| 1884 | 5 | 21 | 0.00 |
| 1884 | 5 | 22 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1884 | 5 | 23 | 0.00 |
| 1884 | 5 | 24 | 0.00 |
| 1884 | 5 | 25 | 0.05 |
| 1884 | 5 | 26 | 0.14 |
| 1884 | 5 | 27 | 0.00 |
| 1884 | 5 | 28 | 0.00 |
| 1884 | 5 | 29 | 0.00 |
| 1884 | 5 | 30 | 0.00 |
| 1884 | 5 | 31 | 0.00 |
| 1884 | 6 | 1  | 0.01 |
| 1884 | 6 | 2  | 0.12 |
| 1884 | 6 | 3  | 0.07 |
| 1884 | 6 | 4  | 0.00 |
| 1884 | 6 | 5  | 0.00 |
| 1884 | 6 | 6  | 0.00 |
| 1884 | 6 | 7  | 0.00 |
| 1884 | 6 | 8  | 0.00 |
| 1884 | 6 | 9  | 0.00 |
| 1884 | 6 | 10 | 0.14 |
| 1884 | 6 | 11 | 0.03 |
| 1884 | 6 | 12 | 0.00 |
| 1884 | 6 | 13 | 0.00 |
| 1884 | 6 | 14 | 0.21 |
| 1884 | 6 | 15 | 0.20 |
| 1884 | 6 | 16 | 0.00 |
| 1884 | 6 | 17 | 0.00 |
| 1884 | 6 | 18 | 0.24 |
| 1884 | 6 | 19 | 0.63 |
| 1884 | 6 | 20 | 0.00 |
| 1884 | 6 | 21 | 0.00 |
| 1884 | 6 | 22 | 0.11 |
| 1884 | 6 | 23 | 0.04 |
| 1884 | 6 | 24 | 0.16 |
| 1884 | 6 | 25 | 0.12 |
| 1884 | 6 | 26 | 0.08 |
| 1884 | 6 | 27 | 0.00 |
| 1884 | 6 | 28 | 0.00 |
| 1884 | 6 | 29 | 0.00 |
| 1884 | 6 | 30 | 0.00 |
| 1884 | 7 | 1  | 0.00 |
| 1884 | 7 | 2  | 0.19 |
| 1884 | 7 | 3  | 0.00 |
| 1884 | 7 | 4  | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1884 | 7 | 5  | 0.02 |
| 1884 | 7 | 6  | 0.35 |
| 1884 | 7 | 7  | 0.05 |
| 1884 | 7 | 8  | 0.00 |
| 1884 | 7 | 9  | 0.00 |
| 1884 | 7 | 10 | 0.00 |
| 1884 | 7 | 11 | 0.00 |
| 1884 | 7 | 12 | 0.00 |
| 1884 | 7 | 13 | 0.00 |
| 1884 | 7 | 14 | 0.00 |
| 1884 | 7 | 15 | 0.05 |
| 1884 | 7 | 16 | 0.65 |
| 1884 | 7 | 17 | 0.14 |
| 1884 | 7 | 18 | 0.00 |
| 1884 | 7 | 19 | 0.00 |
| 1884 | 7 | 20 | 0.00 |
| 1884 | 7 | 21 | 0.00 |
| 1884 | 7 | 22 | 0.13 |
| 1884 | 7 | 23 | 0.02 |
| 1884 | 7 | 24 | 0.00 |
| 1884 | 7 | 25 | 0.00 |
| 1884 | 7 | 26 | 0.00 |
| 1884 | 7 | 27 | 0.02 |
| 1884 | 7 | 28 | 0.00 |
| 1884 | 7 | 29 | 0.03 |
| 1884 | 7 | 30 | 0.06 |
| 1884 | 7 | 31 | 0.02 |
| 1884 | 8 | 1  | 0.00 |
| 1884 | 8 | 2  | 0.00 |
| 1884 | 8 | 3  | 0.00 |
| 1884 | 8 | 4  | 0.00 |
| 1884 | 8 | 5  | 0.06 |
| 1884 | 8 | 6  | 0.00 |
| 1884 | 8 | 7  | 0.00 |
| 1884 | 8 | 8  | 0.00 |
| 1884 | 8 | 9  | 0.00 |
| 1884 | 8 | 10 | 0.01 |
| 1884 | 8 | 11 | 0.00 |
| 1884 | 8 | 12 | 0.00 |
| 1884 | 8 | 13 | 0.10 |
| 1884 | 8 | 14 | 0.00 |
| 1884 | 8 | 15 | 0.00 |
| 1884 | 8 | 16 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1884 | 8 | 17 | 0.00 |
| 1884 | 8 | 18 | 0.00 |
| 1884 | 8 | 19 | 0.00 |
| 1884 | 8 | 20 | 0.00 |
| 1884 | 8 | 21 | 0.00 |
| 1884 | 8 | 22 | 0.00 |
| 1884 | 8 | 23 | 0.04 |
| 1884 | 8 | 24 | 0.00 |
| 1884 | 8 | 25 | 0.00 |
| 1884 | 8 | 26 | 0.79 |
| 1884 | 8 | 27 | 0.01 |
| 1884 | 8 | 28 | 0.00 |
| 1884 | 8 | 29 | 0.00 |
| 1884 | 8 | 30 | 0.11 |
| 1884 | 8 | 31 | 0.11 |
| 1884 | 9 | 1  | 0.03 |
| 1884 | 9 | 2  | 0.11 |
| 1884 | 9 | 3  | 0.16 |
| 1884 | 9 | 4  | 0.39 |
| 1884 | 9 | 5  | 0.01 |
| 1884 | 9 | 6  | 0.00 |
| 1884 | 9 | 7  | 0.01 |
| 1884 | 9 | 8  | 0.07 |
| 1884 | 9 | 9  | 0.87 |
| 1884 | 9 | 10 | 1.13 |
| 1884 | 9 | 11 | 0.96 |
| 1884 | 9 | 12 | 0.14 |
| 1884 | 9 | 13 | 0.15 |
| 1884 | 9 | 14 | 0.12 |
| 1884 | 9 | 15 | 0.33 |
| 1884 | 9 | 16 | 0.00 |
| 1884 | 9 | 17 | 0.00 |
| 1884 | 9 | 18 | 0.00 |
| 1884 | 9 | 19 | 0.00 |
| 1884 | 9 | 20 | 0.06 |
| 1884 | 9 | 21 | 0.30 |
| 1884 | 9 | 22 | 0.01 |
| 1884 | 9 | 23 | 0.00 |
| 1884 | 9 | 24 | 0.00 |
| 1884 | 9 | 25 | 0.00 |
| 1884 | 9 | 26 | 0.03 |
| 1884 | 9 | 27 | 0.11 |
| 1884 | 9 | 28 | 0.34 |

|      |    |    |      |
|------|----|----|------|
| 1884 | 9  | 29 | 0.52 |
| 1884 | 9  | 30 | 0.43 |
| 1884 | 10 | 1  | 0.00 |
| 1884 | 10 | 2  | 0.00 |
| 1884 | 10 | 3  | 0.00 |
| 1884 | 10 | 4  | 0.34 |
| 1884 | 10 | 5  | 0.07 |
| 1884 | 10 | 6  | 0.04 |
| 1884 | 10 | 7  | 0.18 |
| 1884 | 10 | 8  | 0.84 |
| 1884 | 10 | 9  | 0.86 |
| 1884 | 10 | 10 | 0.47 |
| 1884 | 10 | 11 | 0.58 |
| 1884 | 10 | 12 | 0.33 |
| 1884 | 10 | 13 | 0.38 |
| 1884 | 10 | 14 | 0.00 |
| 1884 | 10 | 15 | 0.00 |
| 1884 | 10 | 16 | 0.00 |
| 1884 | 10 | 17 | 0.00 |
| 1884 | 10 | 18 | 0.32 |
| 1884 | 10 | 19 | 0.06 |
| 1884 | 10 | 20 | 0.01 |
| 1884 | 10 | 21 | 0.00 |
| 1884 | 10 | 22 | 0.01 |
| 1884 | 10 | 23 | 0.00 |
| 1884 | 10 | 24 | 0.27 |
| 1884 | 10 | 25 | 0.30 |
| 1884 | 10 | 26 | 0.00 |
| 1884 | 10 | 27 | 0.13 |
| 1884 | 10 | 28 | 0.16 |
| 1884 | 10 | 29 | 0.28 |
| 1884 | 10 | 30 | 0.54 |
| 1884 | 10 | 31 | 0.07 |
| 1884 | 11 | 1  | 0.40 |
| 1884 | 11 | 2  | 0.03 |
| 1884 | 11 | 3  | 1.01 |
| 1884 | 11 | 4  | 0.68 |
| 1884 | 11 | 5  | 0.00 |
| 1884 | 11 | 6  | 0.21 |
| 1884 | 11 | 7  | 0.05 |
| 1884 | 11 | 8  | 0.20 |
| 1884 | 11 | 9  | 0.13 |
| 1884 | 11 | 10 | 0.58 |

|      |    |    |      |
|------|----|----|------|
| 1884 | 11 | 11 | 0.03 |
| 1884 | 11 | 12 | 0.00 |
| 1884 | 11 | 13 | 0.00 |
| 1884 | 11 | 14 | 0.07 |
| 1884 | 11 | 15 | 0.01 |
| 1884 | 11 | 16 | 0.00 |
| 1884 | 11 | 17 | 0.00 |
| 1884 | 11 | 18 | 0.00 |
| 1884 | 11 | 19 | 0.00 |
| 1884 | 11 | 20 | 0.00 |
| 1884 | 11 | 21 | 0.00 |
| 1884 | 11 | 22 | 0.00 |
| 1884 | 11 | 23 | 0.12 |
| 1884 | 11 | 24 | 0.28 |
| 1884 | 11 | 25 | 0.22 |
| 1884 | 11 | 26 | 0.03 |
| 1884 | 11 | 27 | 0.00 |
| 1884 | 11 | 28 | 0.00 |
| 1884 | 11 | 29 | 0.00 |
| 1884 | 11 | 30 | 0.00 |
| 1884 | 12 | 1  | 0.52 |
| 1884 | 12 | 2  | 0.24 |
| 1884 | 12 | 3  | 0.22 |
| 1884 | 12 | 4  | 0.47 |
| 1884 | 12 | 5  | 0.08 |
| 1884 | 12 | 6  | 0.00 |
| 1884 | 12 | 7  | 0.00 |
| 1884 | 12 | 8  | 0.00 |
| 1884 | 12 | 9  | 0.00 |
| 1884 | 12 | 10 | 0.00 |
| 1884 | 12 | 11 | 0.01 |
| 1884 | 12 | 12 | 0.00 |
| 1884 | 12 | 13 | 0.48 |
| 1884 | 12 | 14 | 0.05 |
| 1884 | 12 | 15 | 0.00 |
| 1884 | 12 | 16 | 0.00 |
| 1884 | 12 | 17 | 0.00 |
| 1884 | 12 | 18 | 1.66 |
| 1884 | 12 | 19 | 1.13 |
| 1884 | 12 | 20 | 0.10 |
| 1884 | 12 | 21 | 0.25 |
| 1884 | 12 | 22 | 0.01 |
| 1884 | 12 | 23 | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1884 | 12 | 24 | 0.00 |
| 1884 | 12 | 25 | 0.26 |
| 1884 | 12 | 26 | 0.31 |
| 1884 | 12 | 27 | 0.06 |
| 1884 | 12 | 28 | 0.02 |
| 1884 | 12 | 29 | 0.00 |
| 1884 | 12 | 30 | 0.00 |
| 1884 | 12 | 31 | 0.04 |
| 1885 | 1  | 1  | 0.18 |
| 1885 | 1  | 2  | 0.68 |
| 1885 | 1  | 3  | 1.24 |
| 1885 | 1  | 4  | 0.36 |
| 1885 | 1  | 5  | 0.45 |
| 1885 | 1  | 6  | 0.68 |
| 1885 | 1  | 7  | 1.21 |
| 1885 | 1  | 8  | 0.00 |
| 1885 | 1  | 9  | 0.00 |
| 1885 | 1  | 10 | 0.00 |
| 1885 | 1  | 11 | 0.00 |
| 1885 | 1  | 12 | 0.00 |
| 1885 | 1  | 13 | 0.00 |
| 1885 | 1  | 14 | 0.00 |
| 1885 | 1  | 15 | 0.00 |
| 1885 | 1  | 16 | 0.07 |
| 1885 | 1  | 17 | 0.55 |
| 1885 | 1  | 18 | 0.06 |
| 1885 | 1  | 19 | 0.02 |
| 1885 | 1  | 20 | 0.00 |
| 1885 | 1  | 21 | 0.03 |
| 1885 | 1  | 22 | 0.09 |
| 1885 | 1  | 23 | 0.00 |
| 1885 | 1  | 24 | 0.00 |
| 1885 | 1  | 25 | 0.00 |
| 1885 | 1  | 26 | 0.00 |
| 1885 | 1  | 27 | 0.00 |
| 1885 | 1  | 28 | 0.10 |
| 1885 | 1  | 29 | 0.38 |
| 1885 | 1  | 30 | 0.23 |
| 1885 | 1  | 31 | 0.35 |
| 1885 | 2  | 1  | 0.31 |
| 1885 | 2  | 2  | 0.27 |
| 1885 | 2  | 3  | 0.89 |
| 1885 | 2  | 4  | 0.01 |

|      |   |    |      |
|------|---|----|------|
| 1885 | 2 | 5  | 0.11 |
| 1885 | 2 | 6  | 0.26 |
| 1885 | 2 | 7  | 0.00 |
| 1885 | 2 | 8  | 0.17 |
| 1885 | 2 | 9  | 1.09 |
| 1885 | 2 | 10 | 0.39 |
| 1885 | 2 | 11 | 0.12 |
| 1885 | 2 | 12 | 0.13 |
| 1885 | 2 | 13 | 0.45 |
| 1885 | 2 | 14 | 0.32 |
| 1885 | 2 | 15 | 0.13 |
| 1885 | 2 | 16 | 0.22 |
| 1885 | 2 | 17 | 0.31 |
| 1885 | 2 | 18 | 1.50 |
| 1885 | 2 | 19 | 0.82 |
| 1885 | 2 | 20 | 0.15 |
| 1885 | 2 | 21 | 0.00 |
| 1885 | 2 | 22 | 0.00 |
| 1885 | 2 | 23 | 0.01 |
| 1885 | 2 | 24 | 0.44 |
| 1885 | 2 | 25 | 1.76 |
| 1885 | 2 | 26 | 1.33 |
| 1885 | 2 | 27 | 0.01 |
| 1885 | 2 | 28 | 0.00 |
| 1885 | 3 | 1  | 0.17 |
| 1885 | 3 | 2  | 0.00 |
| 1885 | 3 | 3  | 0.09 |
| 1885 | 3 | 4  | 0.20 |
| 1885 | 3 | 5  | 0.10 |
| 1885 | 3 | 6  | 0.05 |
| 1885 | 3 | 7  | 0.00 |
| 1885 | 3 | 8  | 0.00 |
| 1885 | 3 | 9  | 0.08 |
| 1885 | 3 | 10 | 0.44 |
| 1885 | 3 | 11 | 0.00 |
| 1885 | 3 | 12 | 0.00 |
| 1885 | 3 | 13 | 0.00 |
| 1885 | 3 | 14 | 0.00 |
| 1885 | 3 | 15 | 0.00 |
| 1885 | 3 | 16 | 0.02 |
| 1885 | 3 | 17 | 0.00 |
| 1885 | 3 | 18 | 0.00 |
| 1885 | 3 | 19 | 0.00 |



|      |   |    |      |
|------|---|----|------|
| 1885 | 3 | 20 | 0.00 |
| 1885 | 3 | 21 | 0.00 |
| 1885 | 3 | 22 | 0.00 |
| 1885 | 3 | 23 | 0.00 |
| 1885 | 3 | 24 | 0.00 |
| 1885 | 3 | 25 | 0.00 |
| 1885 | 3 | 26 | 0.00 |
| 1885 | 3 | 27 | 0.00 |
| 1885 | 3 | 28 | 0.00 |
| 1885 | 3 | 29 | 0.00 |
| 1885 | 3 | 30 | 0.00 |
| 1885 | 3 | 31 | 0.00 |
| 1885 | 4 | 1  | 0.00 |
| 1885 | 4 | 2  | 0.00 |
| 1885 | 4 | 3  | 0.00 |
| 1885 | 4 | 4  | 0.00 |
| 1885 | 4 | 5  | 0.01 |
| 1885 | 4 | 6  | 0.02 |
| 1885 | 4 | 7  | 0.00 |
| 1885 | 4 | 8  | 0.00 |
| 1885 | 4 | 9  | 0.00 |
| 1885 | 4 | 10 | 0.00 |
| 1885 | 4 | 11 | 0.00 |
| 1885 | 4 | 12 | 0.21 |
| 1885 | 4 | 13 | 0.00 |
| 1885 | 4 | 14 | 0.00 |
| 1885 | 4 | 15 | 0.06 |
| 1885 | 4 | 16 | 0.39 |
| 1885 | 4 | 17 | 0.38 |
| 1885 | 4 | 18 | 0.00 |
| 1885 | 4 | 19 | 0.00 |
| 1885 | 4 | 20 | 0.00 |
| 1885 | 4 | 21 | 0.00 |
| 1885 | 4 | 22 | 0.00 |
| 1885 | 4 | 23 | 0.00 |
| 1885 | 4 | 24 | 0.00 |
| 1885 | 4 | 25 | 0.00 |
| 1885 | 4 | 26 | 0.00 |
| 1885 | 4 | 27 | 0.00 |
| 1885 | 4 | 28 | 0.03 |
| 1885 | 4 | 29 | 0.02 |
| 1885 | 4 | 30 | 0.00 |
| 1885 | 5 | 1  | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1885 | 5 | 2  | 0.00 |
| 1885 | 5 | 3  | 0.00 |
| 1885 | 5 | 4  | 0.00 |
| 1885 | 5 | 5  | 0.01 |
| 1885 | 5 | 6  | 0.00 |
| 1885 | 5 | 7  | 0.07 |
| 1885 | 5 | 8  | 0.10 |
| 1885 | 5 | 9  | 0.00 |
| 1885 | 5 | 10 | 0.00 |
| 1885 | 5 | 11 | 0.00 |
| 1885 | 5 | 12 | 0.03 |
| 1885 | 5 | 13 | 0.40 |
| 1885 | 5 | 14 | 0.29 |
| 1885 | 5 | 15 | 0.06 |
| 1885 | 5 | 16 | 0.00 |
| 1885 | 5 | 17 | 0.00 |
| 1885 | 5 | 18 | 0.25 |
| 1885 | 5 | 19 | 0.58 |
| 1885 | 5 | 20 | 0.49 |
| 1885 | 5 | 21 | 0.39 |
| 1885 | 5 | 22 | 0.24 |
| 1885 | 5 | 23 | 0.00 |
| 1885 | 5 | 24 | 0.19 |
| 1885 | 5 | 25 | 0.30 |
| 1885 | 5 | 26 | 0.00 |
| 1885 | 5 | 27 | 0.00 |
| 1885 | 5 | 28 | 0.00 |
| 1885 | 5 | 29 | 0.00 |
| 1885 | 5 | 30 | 0.05 |
| 1885 | 5 | 31 | 0.00 |
| 1885 | 6 | 1  | 0.15 |
| 1885 | 6 | 2  | 0.00 |
| 1885 | 6 | 3  | 0.00 |
| 1885 | 6 | 4  | 0.00 |
| 1885 | 6 | 5  | 0.08 |
| 1885 | 6 | 6  | 0.03 |
| 1885 | 6 | 7  | 0.00 |
| 1885 | 6 | 8  | 0.00 |
| 1885 | 6 | 9  | 0.35 |
| 1885 | 6 | 10 | 0.09 |
| 1885 | 6 | 11 | 0.01 |
| 1885 | 6 | 12 | 0.02 |
| 1885 | 6 | 13 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1885 | 6 | 14 | 0.04 |
| 1885 | 6 | 15 | 0.00 |
| 1885 | 6 | 16 | 1.29 |
| 1885 | 6 | 17 | 0.65 |
| 1885 | 6 | 18 | 0.09 |
| 1885 | 6 | 19 | 0.05 |
| 1885 | 6 | 20 | 0.00 |
| 1885 | 6 | 21 | 0.00 |
| 1885 | 6 | 22 | 0.00 |
| 1885 | 6 | 23 | 0.00 |
| 1885 | 6 | 24 | 0.00 |
| 1885 | 6 | 25 | 0.00 |
| 1885 | 6 | 26 | 0.37 |
| 1885 | 6 | 27 | 0.00 |
| 1885 | 6 | 28 | 0.02 |
| 1885 | 6 | 29 | 0.02 |
| 1885 | 6 | 30 | 0.07 |
| 1885 | 7 | 1  | 0.03 |
| 1885 | 7 | 2  | 0.00 |
| 1885 | 7 | 3  | 0.00 |
| 1885 | 7 | 4  | 0.02 |
| 1885 | 7 | 5  | 0.00 |
| 1885 | 7 | 6  | 0.00 |
| 1885 | 7 | 7  | 0.00 |
| 1885 | 7 | 8  | 0.00 |
| 1885 | 7 | 9  | 0.01 |
| 1885 | 7 | 10 | 0.00 |
| 1885 | 7 | 11 | 0.00 |
| 1885 | 7 | 12 | 0.01 |
| 1885 | 7 | 13 | 0.00 |
| 1885 | 7 | 14 | 0.00 |
| 1885 | 7 | 15 | 0.00 |
| 1885 | 7 | 16 | 0.00 |
| 1885 | 7 | 17 | 0.00 |
| 1885 | 7 | 18 | 0.11 |
| 1885 | 7 | 19 | 0.00 |
| 1885 | 7 | 20 | 0.03 |
| 1885 | 7 | 21 | 0.00 |
| 1885 | 7 | 22 | 0.00 |
| 1885 | 7 | 23 | 0.00 |
| 1885 | 7 | 24 | 0.00 |
| 1885 | 7 | 25 | 0.01 |
| 1885 | 7 | 26 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1885 | 7 | 27 | 0.00 |
| 1885 | 7 | 28 | 0.00 |
| 1885 | 7 | 29 | 0.00 |
| 1885 | 7 | 30 | 0.00 |
| 1885 | 7 | 31 | 0.00 |
| 1885 | 8 | 1  | 0.00 |
| 1885 | 8 | 2  | 0.00 |
| 1885 | 8 | 3  | 0.00 |
| 1885 | 8 | 4  | 0.00 |
| 1885 | 8 | 5  | 0.00 |
| 1885 | 8 | 6  | 0.00 |
| 1885 | 8 | 7  | 0.00 |
| 1885 | 8 | 8  | 0.00 |
| 1885 | 8 | 9  | 0.00 |
| 1885 | 8 | 10 | 0.00 |
| 1885 | 8 | 11 | 0.00 |
| 1885 | 8 | 12 | 0.01 |
| 1885 | 8 | 13 | 0.01 |
| 1885 | 8 | 14 | 0.00 |
| 1885 | 8 | 15 | 0.00 |
| 1885 | 8 | 16 | 0.00 |
| 1885 | 8 | 17 | 0.02 |
| 1885 | 8 | 18 | 0.00 |
| 1885 | 8 | 19 | 0.00 |
| 1885 | 8 | 20 | 0.00 |
| 1885 | 8 | 21 | 0.02 |
| 1885 | 8 | 22 | 0.06 |
| 1885 | 8 | 23 | 0.00 |
| 1885 | 8 | 24 | 0.00 |
| 1885 | 8 | 25 | 0.00 |
| 1885 | 8 | 26 | 0.00 |
| 1885 | 8 | 27 | 0.00 |
| 1885 | 8 | 28 | 0.00 |
| 1885 | 8 | 29 | 0.00 |
| 1885 | 8 | 30 | 0.00 |
| 1885 | 8 | 31 | 0.00 |
| 1885 | 9 | 1  | 0.00 |
| 1885 | 9 | 2  | 0.00 |
| 1885 | 9 | 3  | 0.00 |
| 1885 | 9 | 4  | 0.00 |
| 1885 | 9 | 5  | 0.00 |
| 1885 | 9 | 6  | 0.00 |
| 1885 | 9 | 7  | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1885 | 9  | 8  | 0.62 |
| 1885 | 9  | 9  | 0.32 |
| 1885 | 9  | 10 | 0.07 |
| 1885 | 9  | 11 | 0.20 |
| 1885 | 9  | 12 | 0.48 |
| 1885 | 9  | 13 | 0.03 |
| 1885 | 9  | 14 | 0.40 |
| 1885 | 9  | 15 | 0.17 |
| 1885 | 9  | 16 | 0.01 |
| 1885 | 9  | 17 | 0.00 |
| 1885 | 9  | 18 | 0.06 |
| 1885 | 9  | 19 | 0.03 |
| 1885 | 9  | 20 | 0.22 |
| 1885 | 9  | 21 | 0.01 |
| 1885 | 9  | 22 | 0.00 |
| 1885 | 9  | 23 | 0.26 |
| 1885 | 9  | 24 | 0.00 |
| 1885 | 9  | 25 | 0.00 |
| 1885 | 9  | 26 | 0.03 |
| 1885 | 9  | 27 | 0.07 |
| 1885 | 9  | 28 | 0.45 |
| 1885 | 9  | 29 | 0.00 |
| 1885 | 9  | 30 | 0.00 |
| 1885 | 10 | 1  | 0.00 |
| 1885 | 10 | 2  | 0.00 |
| 1885 | 10 | 3  | 0.00 |
| 1885 | 10 | 4  | 0.00 |
| 1885 | 10 | 5  | 0.00 |
| 1885 | 10 | 6  | 0.00 |
| 1885 | 10 | 7  | 0.00 |
| 1885 | 10 | 8  | 0.00 |
| 1885 | 10 | 9  | 0.28 |
| 1885 | 10 | 10 | 0.07 |
| 1885 | 10 | 11 | 0.00 |
| 1885 | 10 | 12 | 0.10 |
| 1885 | 10 | 13 | 0.05 |
| 1885 | 10 | 14 | 0.00 |
| 1885 | 10 | 15 | 0.04 |
| 1885 | 10 | 16 | 0.00 |
| 1885 | 10 | 17 | 0.00 |
| 1885 | 10 | 18 | 0.00 |
| 1885 | 10 | 19 | 0.00 |
| 1885 | 10 | 20 | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1885 | 10 | 21 | 0.03 |
| 1885 | 10 | 22 | 0.02 |
| 1885 | 10 | 23 | 0.00 |
| 1885 | 10 | 24 | 0.38 |
| 1885 | 10 | 25 | 0.08 |
| 1885 | 10 | 26 | 0.11 |
| 1885 | 10 | 27 | 0.58 |
| 1885 | 10 | 28 | 0.16 |
| 1885 | 10 | 29 | 0.57 |
| 1885 | 10 | 30 | 0.20 |
| 1885 | 10 | 31 | 0.81 |
| 1885 | 11 | 1  | 0.67 |
| 1885 | 11 | 2  | 0.78 |
| 1885 | 11 | 3  | 0.87 |
| 1885 | 11 | 4  | 0.78 |
| 1885 | 11 | 5  | 0.10 |
| 1885 | 11 | 6  | 0.32 |
| 1885 | 11 | 7  | 0.59 |
| 1885 | 11 | 8  | 0.91 |
| 1885 | 11 | 9  | 1.40 |
| 1885 | 11 | 10 | 0.00 |
| 1885 | 11 | 11 | 0.53 |
| 1885 | 11 | 12 | 0.32 |
| 1885 | 11 | 13 | 0.48 |
| 1885 | 11 | 14 | 0.20 |
| 1885 | 11 | 15 | 0.29 |
| 1885 | 11 | 16 | 0.26 |
| 1885 | 11 | 17 | 0.13 |
| 1885 | 11 | 18 | 0.66 |
| 1885 | 11 | 19 | 0.00 |
| 1885 | 11 | 20 | 0.43 |
| 1885 | 11 | 21 | 0.26 |
| 1885 | 11 | 22 | 0.39 |
| 1885 | 11 | 23 | 0.39 |
| 1885 | 11 | 24 | 0.46 |
| 1885 | 11 | 25 | 0.90 |
| 1885 | 11 | 26 | 0.80 |
| 1885 | 11 | 27 | 0.62 |
| 1885 | 11 | 28 | 0.08 |
| 1885 | 11 | 29 | 0.08 |
| 1885 | 11 | 30 | 0.02 |
| 1885 | 12 | 1  | 0.03 |
| 1885 | 12 | 2  | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1885 | 12 | 3  | 0.07 |
| 1885 | 12 | 4  | 0.00 |
| 1885 | 12 | 5  | 0.22 |
| 1885 | 12 | 6  | 0.40 |
| 1885 | 12 | 7  | 0.03 |
| 1885 | 12 | 8  | 0.69 |
| 1885 | 12 | 9  | 0.40 |
| 1885 | 12 | 10 | 0.00 |
| 1885 | 12 | 11 | 0.00 |
| 1885 | 12 | 12 | 0.00 |
| 1885 | 12 | 13 | 0.00 |
| 1885 | 12 | 14 | 0.34 |
| 1885 | 12 | 15 | 0.72 |
| 1885 | 12 | 16 | 0.92 |
| 1885 | 12 | 17 | 0.56 |
| 1885 | 12 | 18 | 0.63 |
| 1885 | 12 | 19 | 0.03 |
| 1885 | 12 | 20 | 0.10 |
| 1885 | 12 | 21 | 0.52 |
| 1885 | 12 | 22 | 0.48 |
| 1885 | 12 | 23 | 0.18 |
| 1885 | 12 | 24 | 0.88 |
| 1885 | 12 | 25 | 0.45 |
| 1885 | 12 | 26 | 0.03 |
| 1885 | 12 | 27 | 0.89 |
| 1885 | 12 | 28 | 0.24 |
| 1885 | 12 | 29 | 0.84 |
| 1885 | 12 | 30 | 0.78 |
| 1885 | 12 | 31 | 0.13 |
| 1886 | 1  | 1  | 0.20 |
| 1886 | 1  | 2  | 0.18 |
| 1886 | 1  | 3  | 0.17 |
| 1886 | 1  | 4  | 0.99 |
| 1886 | 1  | 5  | 0.01 |
| 1886 | 1  | 6  | 0.00 |
| 1886 | 1  | 7  | 0.00 |
| 1886 | 1  | 8  | 0.00 |
| 1886 | 1  | 9  | 0.08 |
| 1886 | 1  | 10 | 0.02 |
| 1886 | 1  | 11 | 0.00 |
| 1886 | 1  | 12 | 0.15 |
| 1886 | 1  | 13 | 0.42 |
| 1886 | 1  | 14 | 0.26 |

|      |   |    |      |
|------|---|----|------|
| 1886 | 1 | 15 | 0.00 |
| 1886 | 1 | 16 | 0.00 |
| 1886 | 1 | 17 | 0.00 |
| 1886 | 1 | 18 | 0.07 |
| 1886 | 1 | 19 | 0.02 |
| 1886 | 1 | 20 | 0.00 |
| 1886 | 1 | 21 | 0.00 |
| 1886 | 1 | 22 | 1.06 |
| 1886 | 1 | 23 | 0.47 |
| 1886 | 1 | 24 | 0.17 |
| 1886 | 1 | 25 | 0.44 |
| 1886 | 1 | 26 | 0.45 |
| 1886 | 1 | 27 | 0.32 |
| 1886 | 1 | 28 | 0.50 |
| 1886 | 1 | 29 | 0.13 |
| 1886 | 1 | 30 | 0.06 |
| 1886 | 1 | 31 | 0.28 |
| 1886 | 2 | 1  | 0.21 |
| 1886 | 2 | 2  | 0.55 |
| 1886 | 2 | 3  | 0.22 |
| 1886 | 2 | 4  | 0.00 |
| 1886 | 2 | 5  | 0.00 |
| 1886 | 2 | 6  | 0.48 |
| 1886 | 2 | 7  | 0.66 |
| 1886 | 2 | 8  | 0.72 |
| 1886 | 2 | 9  | 0.05 |
| 1886 | 2 | 10 | 0.50 |
| 1886 | 2 | 11 | 0.00 |
| 1886 | 2 | 12 | 0.49 |
| 1886 | 2 | 13 | 0.20 |
| 1886 | 2 | 14 | 0.08 |
| 1886 | 2 | 15 | 0.00 |
| 1886 | 2 | 16 | 0.00 |
| 1886 | 2 | 17 | 0.01 |
| 1886 | 2 | 18 | 0.00 |
| 1886 | 2 | 19 | 0.00 |
| 1886 | 2 | 20 | 0.00 |
| 1886 | 2 | 21 | 0.00 |
| 1886 | 2 | 22 | 0.00 |
| 1886 | 2 | 23 | 0.00 |
| 1886 | 2 | 24 | 0.01 |
| 1886 | 2 | 25 | 0.24 |
| 1886 | 2 | 26 | 0.53 |



|      |   |    |      |
|------|---|----|------|
| 1886 | 2 | 27 | 0.02 |
| 1886 | 2 | 28 | 0.00 |
| 1886 | 3 | 1  | 0.00 |
| 1886 | 3 | 2  | 0.00 |
| 1886 | 3 | 3  | 0.00 |
| 1886 | 3 | 4  | 0.00 |
| 1886 | 3 | 5  | 0.00 |
| 1886 | 3 | 6  | 0.45 |
| 1886 | 3 | 7  | 0.37 |
| 1886 | 3 | 8  | 0.32 |
| 1886 | 3 | 9  | 0.08 |
| 1886 | 3 | 10 | 0.01 |
| 1886 | 3 | 11 | 0.40 |
| 1886 | 3 | 12 | 0.78 |
| 1886 | 3 | 13 | 0.37 |
| 1886 | 3 | 14 | 0.71 |
| 1886 | 3 | 15 | 0.27 |
| 1886 | 3 | 16 | 0.63 |
| 1886 | 3 | 17 | 0.06 |
| 1886 | 3 | 18 | 0.00 |
| 1886 | 3 | 19 | 0.91 |
| 1886 | 3 | 20 | 0.49 |
| 1886 | 3 | 21 | 1.03 |
| 1886 | 3 | 22 | 0.55 |
| 1886 | 3 | 23 | 0.11 |
| 1886 | 3 | 24 | 0.15 |
| 1886 | 3 | 25 | 0.46 |
| 1886 | 3 | 26 | 0.11 |
| 1886 | 3 | 27 | 0.00 |
| 1886 | 3 | 28 | 0.00 |
| 1886 | 3 | 29 | 0.00 |
| 1886 | 3 | 30 | 0.00 |
| 1886 | 3 | 31 | 0.00 |
| 1886 | 4 | 1  | 0.02 |
| 1886 | 4 | 2  | 0.03 |
| 1886 | 4 | 3  | 0.02 |
| 1886 | 4 | 4  | 0.00 |
| 1886 | 4 | 5  | 0.05 |
| 1886 | 4 | 6  | 0.04 |
| 1886 | 4 | 7  | 0.02 |
| 1886 | 4 | 8  | 0.01 |
| 1886 | 4 | 9  | 0.04 |
| 1886 | 4 | 10 | 0.87 |

|      |   |    |      |
|------|---|----|------|
| 1886 | 4 | 11 | 0.04 |
| 1886 | 4 | 12 | 0.10 |
| 1886 | 4 | 13 | 0.00 |
| 1886 | 4 | 14 | 0.30 |
| 1886 | 4 | 15 | 0.36 |
| 1886 | 4 | 16 | 0.93 |
| 1886 | 4 | 17 | 1.48 |
| 1886 | 4 | 18 | 0.60 |
| 1886 | 4 | 19 | 0.00 |
| 1886 | 4 | 20 | 0.19 |
| 1886 | 4 | 21 | 0.03 |
| 1886 | 4 | 22 | 0.00 |
| 1886 | 4 | 23 | 0.05 |
| 1886 | 4 | 24 | 0.00 |
| 1886 | 4 | 25 | 0.00 |
| 1886 | 4 | 26 | 0.00 |
| 1886 | 4 | 27 | 0.00 |
| 1886 | 4 | 28 | 0.00 |
| 1886 | 4 | 29 | 0.17 |
| 1886 | 4 | 30 | 0.09 |
| 1886 | 5 | 1  | 0.25 |
| 1886 | 5 | 2  | 0.00 |
| 1886 | 5 | 3  | 0.00 |
| 1886 | 5 | 4  | 0.11 |
| 1886 | 5 | 5  | 0.00 |
| 1886 | 5 | 6  | 0.05 |
| 1886 | 5 | 7  | 0.09 |
| 1886 | 5 | 8  | 0.30 |
| 1886 | 5 | 9  | 0.40 |
| 1886 | 5 | 10 | 0.47 |
| 1886 | 5 | 11 | 0.32 |
| 1886 | 5 | 12 | 0.84 |
| 1886 | 5 | 13 | 0.21 |
| 1886 | 5 | 14 | 0.17 |
| 1886 | 5 | 15 | 0.02 |
| 1886 | 5 | 16 | 0.00 |
| 1886 | 5 | 17 | 0.00 |
| 1886 | 5 | 18 | 0.00 |
| 1886 | 5 | 19 | 0.00 |
| 1886 | 5 | 20 | 0.00 |
| 1886 | 5 | 21 | 0.00 |
| 1886 | 5 | 22 | 0.00 |
| 1886 | 5 | 23 | 0.07 |

|      |   |    |      |
|------|---|----|------|
| 1886 | 5 | 24 | 0.01 |
| 1886 | 5 | 25 | 0.00 |
| 1886 | 5 | 26 | 0.03 |
| 1886 | 5 | 27 | 0.09 |
| 1886 | 5 | 28 | 0.00 |
| 1886 | 5 | 29 | 0.00 |
| 1886 | 5 | 30 | 0.00 |
| 1886 | 5 | 31 | 0.00 |
| 1886 | 6 | 1  | 0.00 |
| 1886 | 6 | 2  | 0.00 |
| 1886 | 6 | 3  | 0.00 |
| 1886 | 6 | 4  | 0.00 |
| 1886 | 6 | 5  | 0.00 |
| 1886 | 6 | 6  | 0.17 |
| 1886 | 6 | 7  | 0.01 |
| 1886 | 6 | 8  | 0.00 |
| 1886 | 6 | 9  | 0.04 |
| 1886 | 6 | 10 | 0.00 |
| 1886 | 6 | 11 | 0.00 |
| 1886 | 6 | 12 | 0.00 |
| 1886 | 6 | 13 | 0.00 |
| 1886 | 6 | 14 | 0.00 |
| 1886 | 6 | 15 | 0.00 |
| 1886 | 6 | 16 | 0.09 |
| 1886 | 6 | 17 | 0.00 |
| 1886 | 6 | 18 | 0.80 |
| 1886 | 6 | 19 | 0.33 |
| 1886 | 6 | 20 | 0.00 |
| 1886 | 6 | 21 | 0.00 |
| 1886 | 6 | 22 | 0.00 |
| 1886 | 6 | 23 | 0.00 |
| 1886 | 6 | 24 | 0.00 |
| 1886 | 6 | 25 | 0.00 |
| 1886 | 6 | 26 | 0.00 |
| 1886 | 6 | 27 | 0.01 |
| 1886 | 6 | 28 | 0.87 |
| 1886 | 6 | 29 | 0.00 |
| 1886 | 6 | 30 | 0.35 |
| 1886 | 7 | 1  | 0.45 |
| 1886 | 7 | 2  | 0.11 |
| 1886 | 7 | 3  | 0.00 |
| 1886 | 7 | 4  | 0.20 |
| 1886 | 7 | 5  | 0.92 |

|      |   |    |      |
|------|---|----|------|
| 1886 | 7 | 6  | 0.76 |
| 1886 | 7 | 7  | 0.30 |
| 1886 | 7 | 8  | 0.12 |
| 1886 | 7 | 9  | 0.29 |
| 1886 | 7 | 10 | 0.11 |
| 1886 | 7 | 11 | 0.00 |
| 1886 | 7 | 12 | 0.04 |
| 1886 | 7 | 13 | 0.00 |
| 1886 | 7 | 14 | 0.00 |
| 1886 | 7 | 15 | 0.00 |
| 1886 | 7 | 16 | 0.00 |
| 1886 | 7 | 17 | 0.00 |
| 1886 | 7 | 18 | 0.00 |
| 1886 | 7 | 19 | 0.00 |
| 1886 | 7 | 20 | 0.00 |
| 1886 | 7 | 21 | 0.00 |
| 1886 | 7 | 22 | 0.00 |
| 1886 | 7 | 23 | 0.00 |
| 1886 | 7 | 24 | 0.00 |
| 1886 | 7 | 25 | 0.00 |
| 1886 | 7 | 26 | 0.00 |
| 1886 | 7 | 27 | 0.00 |
| 1886 | 7 | 28 | 0.01 |
| 1886 | 7 | 29 | 0.02 |
| 1886 | 7 | 30 | 0.00 |
| 1886 | 7 | 31 | 0.00 |
| 1886 | 8 | 1  | 0.00 |
| 1886 | 8 | 2  | 0.00 |
| 1886 | 8 | 3  | 0.00 |
| 1886 | 8 | 4  | 0.00 |
| 1886 | 8 | 5  | 0.01 |
| 1886 | 8 | 6  | 0.00 |
| 1886 | 8 | 7  | 0.00 |
| 1886 | 8 | 8  | 0.00 |
| 1886 | 8 | 9  | 0.00 |
| 1886 | 8 | 10 | 0.00 |
| 1886 | 8 | 11 | 0.00 |
| 1886 | 8 | 12 | 0.00 |
| 1886 | 8 | 13 | 0.00 |
| 1886 | 8 | 14 | 0.00 |
| 1886 | 8 | 15 | 0.00 |
| 1886 | 8 | 16 | 0.00 |
| 1886 | 8 | 17 | 0.00 |

|      |   |    |      |
|------|---|----|------|
| 1886 | 8 | 18 | 0.00 |
| 1886 | 8 | 19 | 0.05 |
| 1886 | 8 | 20 | 0.35 |
| 1886 | 8 | 21 | 0.24 |
| 1886 | 8 | 22 | 0.00 |
| 1886 | 8 | 23 | 0.00 |
| 1886 | 8 | 24 | 0.00 |
| 1886 | 8 | 25 | 0.14 |
| 1886 | 8 | 26 | 0.00 |
| 1886 | 8 | 27 | 0.00 |
| 1886 | 8 | 28 | 0.00 |
| 1886 | 8 | 29 | 0.00 |
| 1886 | 8 | 30 | 0.24 |
| 1886 | 8 | 31 | 0.03 |
| 1886 | 9 | 1  | 0.00 |
| 1886 | 9 | 2  | 0.29 |
| 1886 | 9 | 3  | 0.03 |
| 1886 | 9 | 4  | 0.07 |
| 1886 | 9 | 5  | 0.10 |
| 1886 | 9 | 6  | 0.00 |
| 1886 | 9 | 7  | 0.00 |
| 1886 | 9 | 8  | 0.00 |
| 1886 | 9 | 9  | 0.00 |
| 1886 | 9 | 10 | 0.00 |
| 1886 | 9 | 11 | 0.00 |
| 1886 | 9 | 12 | 0.00 |
| 1886 | 9 | 13 | 0.00 |
| 1886 | 9 | 14 | 0.00 |
| 1886 | 9 | 15 | 0.00 |
| 1886 | 9 | 16 | 0.01 |
| 1886 | 9 | 17 | 0.00 |
| 1886 | 9 | 18 | 0.00 |
| 1886 | 9 | 19 | 0.00 |
| 1886 | 9 | 20 | 0.00 |
| 1886 | 9 | 21 | 0.07 |
| 1886 | 9 | 22 | 1.10 |
| 1886 | 9 | 23 | 0.24 |
| 1886 | 9 | 24 | 0.08 |
| 1886 | 9 | 25 | 0.26 |
| 1886 | 9 | 26 | 0.03 |
| 1886 | 9 | 27 | 0.00 |
| 1886 | 9 | 28 | 0.00 |
| 1886 | 9 | 29 | 0.00 |

|      |    |    |      |
|------|----|----|------|
| 1886 | 9  | 30 | 0.00 |
| 1886 | 10 | 1  | 0.00 |
| 1886 | 10 | 2  | 0.00 |
| 1886 | 10 | 3  | 0.01 |
| 1886 | 10 | 4  | 0.06 |
| 1886 | 10 | 5  | 0.01 |
| 1886 | 10 | 6  | 0.24 |
| 1886 | 10 | 7  | 0.03 |
| 1886 | 10 | 8  | 0.64 |
| 1886 | 10 | 9  | 0.21 |
| 1886 | 10 | 10 | 0.00 |
| 1886 | 10 | 11 | 0.00 |
| 1886 | 10 | 12 | 0.34 |
| 1886 | 10 | 13 | 0.40 |
| 1886 | 10 | 14 | 0.73 |
| 1886 | 10 | 15 | 0.26 |
| 1886 | 10 | 16 | 0.00 |
| 1886 | 10 | 17 | 0.05 |
| 1886 | 10 | 18 | 0.00 |
| 1886 | 10 | 19 | 0.00 |
| 1886 | 10 | 20 | 0.00 |
| 1886 | 10 | 21 | 0.00 |
| 1886 | 10 | 22 | 0.52 |
| 1886 | 10 | 23 | 0.00 |
| 1886 | 10 | 24 | 0.00 |
| 1886 | 10 | 25 | 0.00 |
| 1886 | 10 | 26 | 0.00 |
| 1886 | 10 | 27 | 0.28 |
| 1886 | 10 | 28 | 0.07 |
| 1886 | 10 | 29 | 1.26 |
| 1886 | 10 | 30 | 0.03 |
| 1886 | 10 | 31 | 0.00 |
| 1886 | 11 | 1  | 0.00 |
| 1886 | 11 | 2  | 0.00 |
| 1886 | 11 | 3  | 0.03 |
| 1886 | 11 | 4  | 0.00 |
| 1886 | 11 | 5  | 0.00 |
| 1886 | 11 | 6  | 0.00 |
| 1886 | 11 | 7  | 0.00 |
| 1886 | 11 | 8  | 0.52 |
| 1886 | 11 | 9  | 0.00 |
| 1886 | 11 | 10 | 0.01 |
| 1886 | 11 | 11 | 0.11 |

|      |    |    |      |
|------|----|----|------|
| 1886 | 11 | 12 | 1.06 |
| 1886 | 11 | 13 | 0.00 |
| 1886 | 11 | 14 | 0.00 |
| 1886 | 11 | 15 | 0.00 |
| 1886 | 11 | 16 | 0.02 |
| 1886 | 11 | 17 | 0.05 |
| 1886 | 11 | 18 | 0.01 |
| 1886 | 11 | 19 | 1.30 |
| 1886 | 11 | 20 | 0.13 |
| 1886 | 11 | 21 | 0.30 |
| 1886 | 11 | 22 | 0.00 |
| 1886 | 11 | 23 | 0.00 |
| 1886 | 11 | 24 | 0.74 |
| 1886 | 11 | 25 | 0.01 |
| 1886 | 11 | 26 | 0.00 |
| 1886 | 11 | 27 | 0.00 |
| 1886 | 11 | 28 | 0.00 |
| 1886 | 11 | 29 | 0.10 |
| 1886 | 11 | 30 | 0.08 |
| 1886 | 12 | 1  | 0.57 |
| 1886 | 12 | 2  | 0.75 |
| 1886 | 12 | 3  | 0.17 |
| 1886 | 12 | 4  | 0.05 |
| 1886 | 12 | 5  | 0.01 |
| 1886 | 12 | 6  | 1.37 |
| 1886 | 12 | 7  | 1.42 |
| 1886 | 12 | 8  | 0.33 |
| 1886 | 12 | 9  | 0.00 |
| 1886 | 12 | 10 | 0.47 |
| 1886 | 12 | 11 | 0.34 |
| 1886 | 12 | 12 | 1.53 |
| 1886 | 12 | 13 | 0.06 |
| 1886 | 12 | 14 | 0.00 |
| 1886 | 12 | 15 | 0.57 |
| 1886 | 12 | 16 | 0.07 |
| 1886 | 12 | 17 | 0.00 |
| 1886 | 12 | 18 | 0.81 |
| 1886 | 12 | 19 | 0.50 |
| 1886 | 12 | 20 | 0.34 |
| 1886 | 12 | 21 | 1.30 |
| 1886 | 12 | 22 | 0.58 |
| 1886 | 12 | 23 | 0.37 |
| 1886 | 12 | 24 | 0.36 |

|      |    |    |      |
|------|----|----|------|
| 1886 | 12 | 25 | 0.63 |
| 1886 | 12 | 26 | 1.22 |
| 1886 | 12 | 27 | 0.02 |
| 1886 | 12 | 28 | 0.62 |
| 1886 | 12 | 29 | 0.20 |
| 1886 | 12 | 30 | 0.39 |
| 1886 | 12 | 31 | 2.30 |
| 1887 | 1  | 1  | 0.06 |
| 1887 | 1  | 2  | 0.17 |
| 1887 | 1  | 3  | 0.09 |
| 1887 | 1  | 4  | 0.28 |
| 1887 | 1  | 5  | 0.46 |
| 1887 | 1  | 6  | 0.26 |
| 1887 | 1  | 7  | 0.00 |
| 1887 | 1  | 8  | 0.00 |
| 1887 | 1  | 9  | 0.13 |
| 1887 | 1  | 10 | 0.10 |
| 1887 | 1  | 11 | 0.87 |
| 1887 | 1  | 12 | 0.39 |
| 1887 | 1  | 13 | 0.50 |
| 1887 | 1  | 14 | 0.57 |
| 1887 | 1  | 15 | 1.48 |
| 1887 | 1  | 16 | 0.06 |
| 1887 | 1  | 17 | 0.00 |
| 1887 | 1  | 18 | 0.07 |
| 1887 | 1  | 19 | 0.27 |
| 1887 | 1  | 20 | 0.46 |
| 1887 | 1  | 21 | 0.15 |
| 1887 | 1  | 22 | 1.02 |
| 1887 | 1  | 23 | 0.46 |
| 1887 | 1  | 24 | 0.23 |
| 1887 | 1  | 25 | 0.53 |
| 1887 | 1  | 26 | 0.32 |
| 1887 | 1  | 27 | 0.24 |
| 1887 | 1  | 28 | 0.48 |
| 1887 | 1  | 29 | 0.71 |
| 1887 | 1  | 30 | 0.78 |
| 1887 | 1  | 31 | 0.67 |
| 1887 | 2  | 1  | 0.39 |
| 1887 | 2  | 2  | 0.12 |
| 1887 | 2  | 3  | 0.19 |
| 1887 | 2  | 4  | 0.00 |
| 1887 | 2  | 5  | 0.00 |